Modicon eX80

BME AHI 0812 HART Analog Input Module &
BME AHO 0412 HART Analog Output Module
User Guide

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All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

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Safety Information

Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **can result in** death or serious injury.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

About the Book

At a Glance

Document Scope

This manual describes the following eX80 HART analog I/O modules:

- BME AHI 0812 input module
- BME AHO 0412 output module

Validity Note

The eX80 HART analog I/O modules described in this manual require the use of Unity Pro version 8.0 or higher.

Product Related Information

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

The application of this product requires expertise in the design and operation of control systems. Allow only authorized personnel with such expertise to program, install, alter, and apply this product.

Follow all local and national safety codes and standards.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Chapter 1
Introducing the BME AHI 0812 and BME AHO 0412 eX80 HART Analog I/O

Adding HART eX80 Analog I/O to a Modicon X80 Network

Positioning BME AHI 0812 and BME AHO 0412 Modules in a Network

You can use the BME AHI 0812 input module and the BME AHO 0412 output module as:
- local I/O in the main local Ethernet backplane
- remote I/O modules in the main Ethernet rack of a remote I/O drop

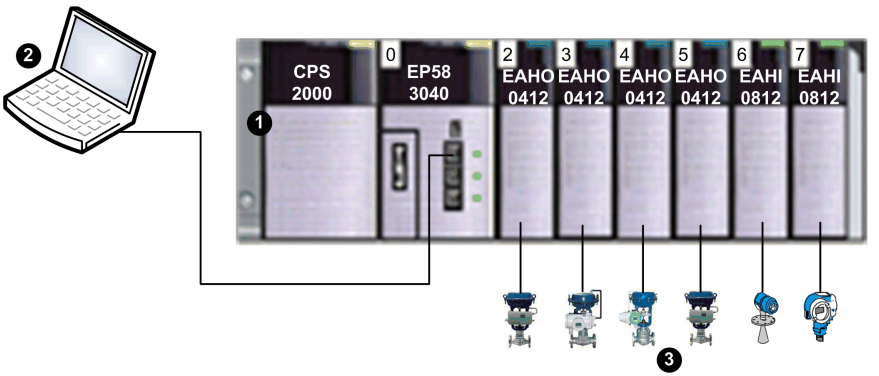
NOTE: You can mount a HART analog eX80 I/O module only in the main segment of a local rack or a remote I/O drop. You cannot mount a HART analog eX80 I/O module in a rack extension.

The BME AHI 0812 input module and the BME AHO 0412 output modules support the following asset management software programs:
- *FieldCare Asset Management Software* by Endress+Hauser
- *PACTware* a free download from the PACTware Consortium

Local I/O

You can add up to 6 HART analog I/O modules to a main local rack. In addition to the I/O modules, the local rack includes the following components:
- a BME XBP xx00 rack
- a BME P58 x0x0 CPU

An example of a single local rack installation:



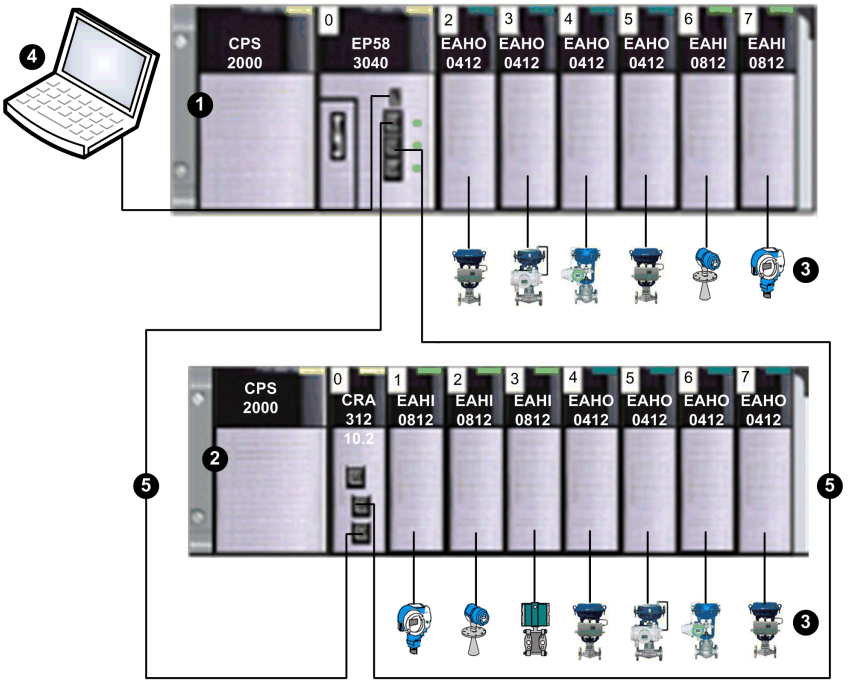
1 Local rack containing a BME P58 3040 CPU, power supply, and 6 I/O modules
2 Maintenance PC, operating as HART primary master, connected to the local rack via Ethernet copper cable
3 HART field instruments connected to I/O via 4-20 mA current loop wiring

Remote I/O

You can add up to 7 HART analog I/O modules to the main rack of a remote I/O drop. In addition to the I/O modules, the remote I/O rack includes the following components:

- a BME XBP xx00 rack
- a BME CRA 312 10 adapter

An example of a single local rack with a remote I/O drop:



1 Local rack containing a BME P58 3040 CPU, power supply, and 6 I/O modules
2 Remote drop containing a BME CRA 312 10 adapter and 7 I/O modules
3 HART field instruments connected to I/O via 4-20 mA current loop wiring
4 Maintenance PC, operating as HART primary master, connected to the local rack via Ethernet copper cable
5 Remote I/O main ring

Chapter 2
Installing HART Analog I/O Modules

Overview

This chapter describes the installation of the HART analog I/O modules, including:

- mounting the module on the backplane
- fitting a 20-pin terminal block to the module
- connecting 20-pin terminal blocks
- selecting TELEFAST wiring accessories

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Installing Analog I/O Modules	14
Fitting a 20-Pin Terminal Block to an Analog I/O Module	17
20-Pin Terminal Blocks	21
How to Connect HART Analog Input/Output Modules: Connecting 20-pin Terminal Block Modules	24
TELEFAST Wiring Accessories for the BME AHI 0812 and BME AHO 0412 HART Analog Modules	27

Installing Analog I/O Modules

At a Glance

The analog I/O modules are powered by the rack bus. The modules may be installed and uninstalled without turning off power supply to the rack.

Fitting operations (installation, assembly, and disassembly) are described below.

Before Installing a Module

Before installing a module, take off the protective cap from the module connector located on the rack.

⚠⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

Before mounting / removing the modules:
- confirm that the terminal block is still connected to the shield bar
- disconnect the voltage of sensors and pre-actuators

Failure to follow these instructions will result in death or serious injury.

NOTE: Modules are calibrated at the factory before being shipped.

Selecting a Backplane

Install the analog I/O modules on one of the following Ethernet backplanes:

Backplane	Description
BME XBP 0400[1]	4-slot Ethernet backplane
BME XBP 0400(H)[1]	4-slot hardened Ethernet backplane
BME XBP 0800[1]	8-slot Ethernet backplane
BME XBP 0800(H)[1]	8-slot hardened Ethernet backplane
BME XBP 1200[1, 2]	12-slot Ethernet backplane
BME XBP 1200(H)[1, 2]	12-slot hardened Ethernet backplane

1. The following reserved slots are not available for module installation:
- In a local rack, slots 0 and 1 are reserved for the CPU.
- In a remote I/O drop, slot 0 is reserved for a BME CRA 312 10 adapter module.

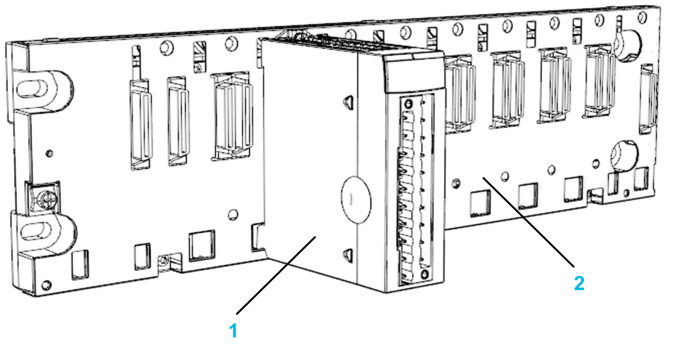
2. The following reserved slots are not available for module installation: slots 2, 8, 10 and 11, which are reserved for gateway communication modules.

The HART analog modules may be installed in any of the slots in the backplane except for the reserved slots described in the table footnotes, above.

Power is supplied to the I/O modules by the bus at the bottom of the rack (3.3 V and 24 V).

Installation

The diagram below shows a HART analog I/O module mounted on the rack.

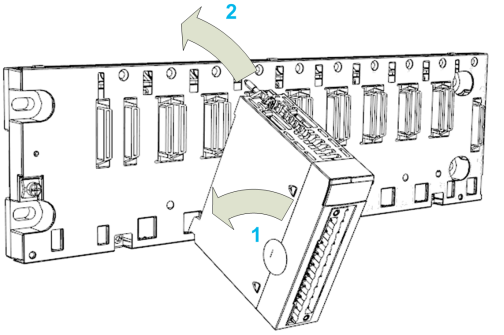
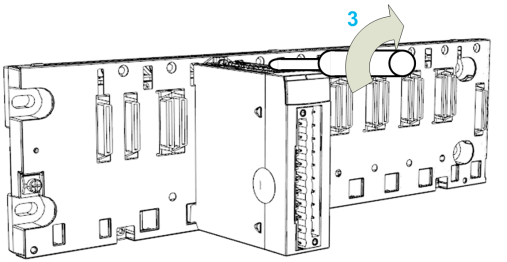


The assembly includes the following components:

Number	Description
1	20-pin terminal block module
2	8 slot Ethernet backplane

Installing the Module on the Rack

To mount the analog I/O modules on the backplane, follow these steps:

Step	Action	Illustration
1	Position the locating pins situated at the rear of the module (on the bottom part) in the corresponding slots in the rack. Note: Before positioning the pins, remove the protective cover.	Steps 1 and 2 
2	Swivel the module towards the top of the rack so that the module sits flush with the back of the rack. It is now set in position.	
3	Tighten the retaining screw to hold the module in place on the rack. Tightening torque: 1.5 N•m max. (1.11 lb-ft)	Step 3 

Fitting a 20-Pin Terminal Block to an Analog I/O Module

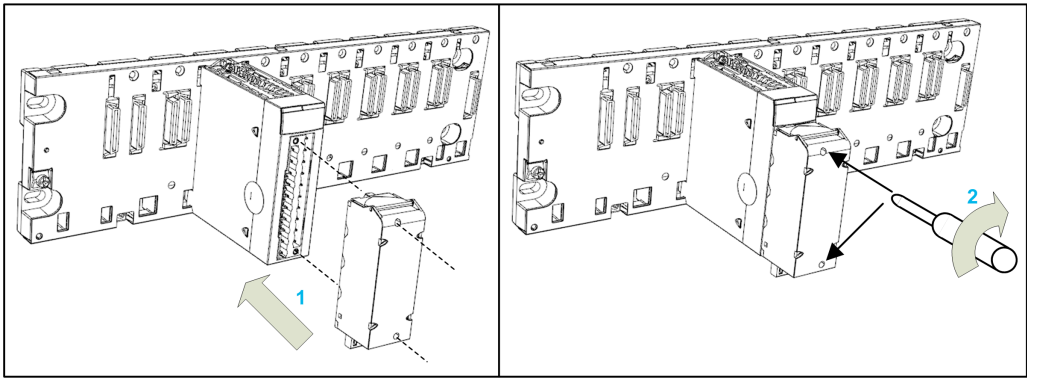
At a Glance

Both the BME AHI 0812 and BME AHO 0412 modules need to be connected to a 20-pin terminal block. The process of fitting a block to a module is described below.

⚠ CAUTION
EQUIPMENT DAMAGE Do not plug an AC terminal block on a DC module. This can cause equipment damage. **Failure to follow these instructions can result in injury or equipment damage.**

Installing the 20-Pin Terminal Block

To fit the 20-pin terminal block onto the BME AHI 0812 and BME AHO 0412 HART analog modules, follow these steps:



Step	Action
1	After the module has been placed onto the rack, install the terminal block by inserting the rear lower part of the terminal into the front lower part of the module, as shown above.
2	Affix the terminal block to the module by tightening the 2 mounting screws located on the lower and upper parts of the terminal block. **NOTE:** Apply a tightening torque of 0.4 N•m (0.30 lb-ft).

NOTE: If the screws are not tightened, the terminal block may not be properly affixed to the module.

Coding the 20-Pin Terminal Block

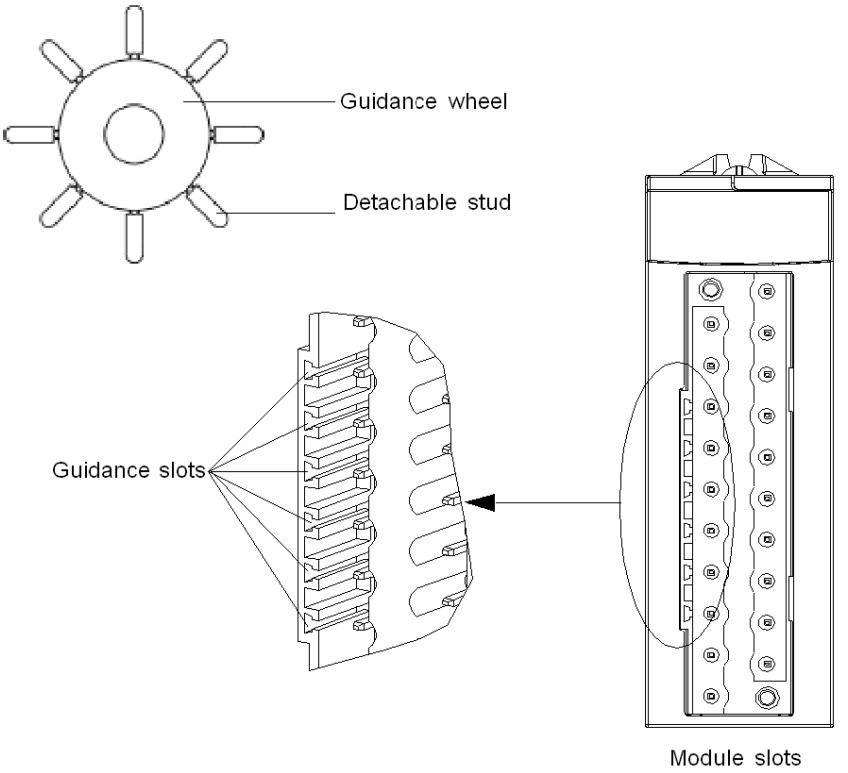
When installing a 20-pin terminal block on a BME AHI 0812 or BME AHO 0412 module, you can code the terminal block so that it may be used only with a particular module. To do this, apply studs to both the terminal block and to the module in a pattern so that the 2 components fit each other, but do not fit other modules or terminal blocks. In this way, you can reduce the likelihood that a terminal block will be mounted on a module other than the intended module.

To perform coding, use the studs on the STB XMP 7800 guidance wheel. You can insert studs in the 6 guidance slots on the left side of the module, and in the corresponding 6 slots in the terminal block.

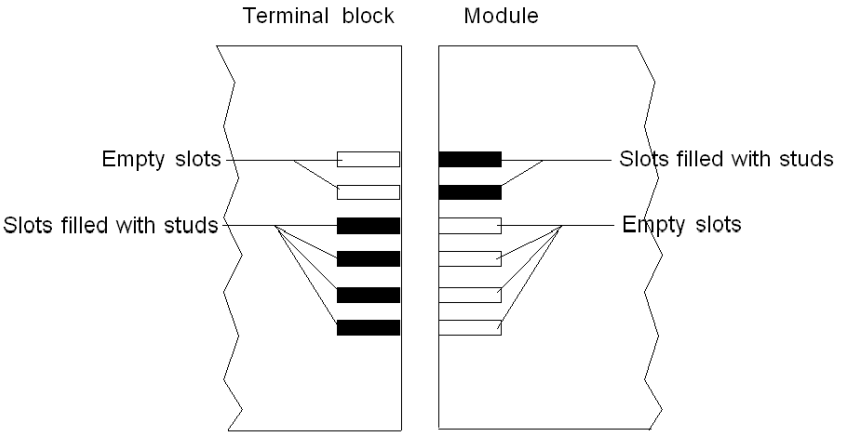
To fit the terminal block to the module:

- a module slot with a stud corresponds to an empty slot in the terminal block, and
- a terminal block slot with a stud corresponds to an empty slot in the module

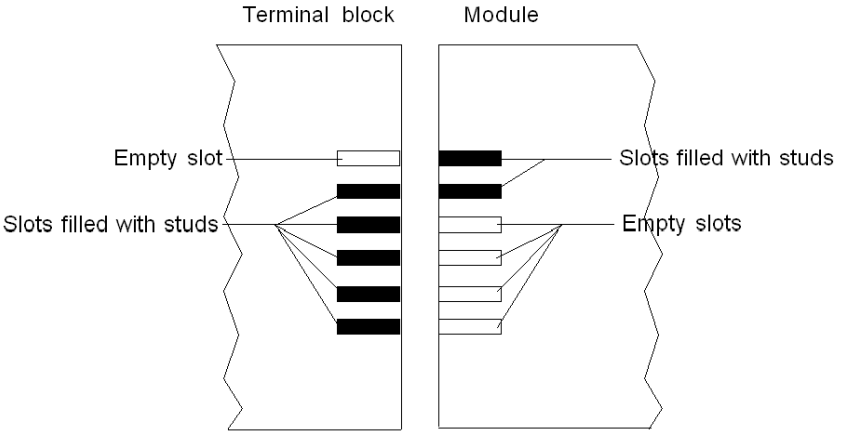
The following diagram depicts a guidance wheel and the slots on the module used for coding the 20-pin terminal blocks:



The following example depicts a coding configuration that allows a terminal block to fit together with a module:



The following example depicts a coding configuration that obstructs the terminal block from fitting onto the module:



⚠ DANGER

ELECTRICAL SHOCK

Connect or disconnect the terminal block with sensor and pre-actuator voltage switched off.

Failure to follow these instructions will result in death or serious injury.

NOTICE

POTENTIAL MODULE DAMAGE

Code the terminal block as described above to help prevent the terminal block from being mounted on an incorrect module. Mounting a terminal block on an incorrect module may damage the module.

Plugging the wrong connector could cause the module to be destroyed.

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

UNEXPECTED BEHAVIOR OF APPLICATION

Code the terminal block as described above to help prevent the terminal block from being mounted on another module.

Plugging the wrong connector could cause unexpected behavior of the application.

Failure to follow these instructions can result in injury or equipment damage.

NOTE: The module connector has indicators that show the proper direction for inserting studs into a terminal block installation.

20-Pin Terminal Blocks

Identifying 20-Pin Terminal Blocks

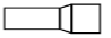
The BME AHI 0812 and BME AHO 0412 modules are supplemented by a 20-pin terminal block.

There are 3 types of 20-pin terminal blocks:

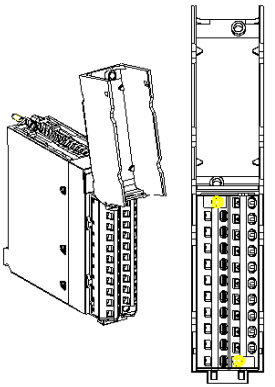
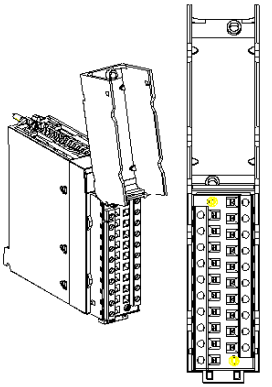
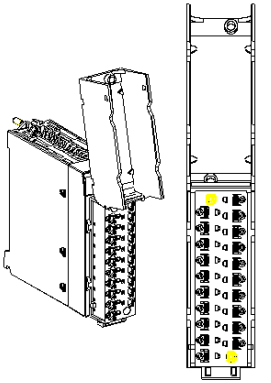
- BMX FTB 2010 screw clamp terminal blocks
- BMX FTB 2000 caged terminal blocks
- BMX FTB 2020 spring terminal blocks

Cable Ends and Contacts

Each terminal block can accommodate:

- Bare wires
- Wires with DZ5-CE type  cable ends

Description of the 20-Pin Terminal Blocks

		Screw Clamp Terminal Blocks	Caged Terminal Blocks	Spring Terminal Blocks
Illustration				
Number of wires accommodated		2	1	1
Number of wire gauges accommodated	minimum	AWG 24 (0.34 mm^2)		
	maximum	AWG 16 (1.5 mm^2)		

	Screw Clamp Terminal Blocks	Caged Terminal Blocks	Spring Terminal Blocks
Wiring constraints	Screw clamps have slots that accept: ● flat-tipped screwdrivers with a diameter of 5 mm ● posidriv n°1 cross-tipped screwdrivers Screw clamp terminal blocks have captive screws. On the supplied blocks, these screws are not tightened.	Caged terminal blocks have slots that accept: ● flat-tipped screwdrivers with a diameter of 3 mm ● posidriv n°1 cross-tipped screwdrivers Caged terminal blocks have captive screws. On the supplied blocks, these screws are not tightened.	The wires are connected by pressing the button located next to each pin. To press the button, use a flat-tipped screwdriver with a maximum diameter of 3 mm.
Maximum screw tightening torque	0.5 N•m (0.37 lb-ft)	0.5 N•m (0.37 lb-ft)	–

⚠ DANGER

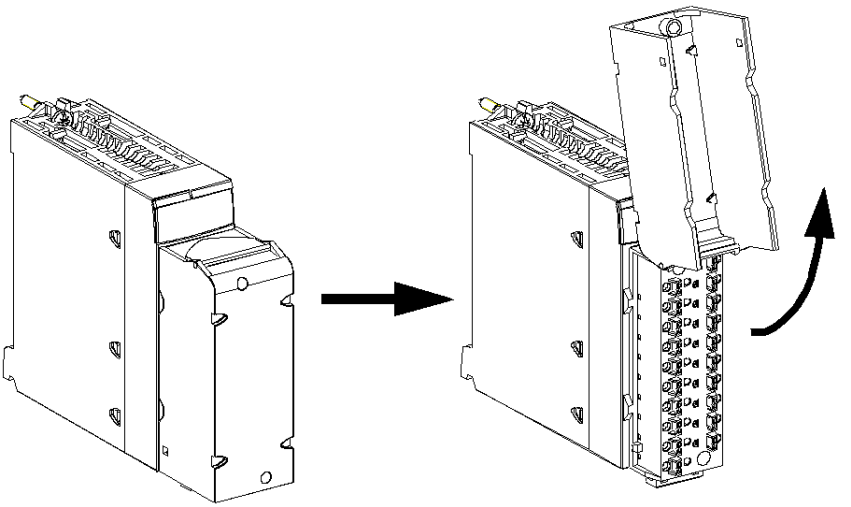
ELECTRICAL SHOCK

Connect or disconnect the terminal block with sensor and pre-actuator voltage switched off.

Failure to follow these instructions will result in death or serious injury.

Connection of 20-Pin Terminal Blocks

To access the 20-pin terminal block for wiring, open the terminal block door as shown below:



The connection cables for 20-pin terminal blocks come with 3 kinds of connections:

- Connection cables with an FTB connector, which come in 2 different lengths:
  - 3 meter: BMX FTW 301S
  - 5 meter: BMX FTW 501S
- Connection cables with FTB and D-Sub25 connectors for direct wiring of the BME AHI 0812 module with Telefast ABE7CPA02, ABE7CPA03, or ABE7CPA31 which come in 2 different lengths:
  - 1.5 meter: BMX FTA 1522,
  - 3 meter: BMX FTA 3022,
- Connection cables for BME AHO 0412 with Telefast ABE7CPA21 which come in 3 different lengths:
  - 1.5 meter: BMX FCA 150
  - 3 meter: BMX FCA 300
  - 5 meter: BMX FCA 500

NOTE: The connection cable is installed and held in place by a cable clamp positioned below the 20-pin terminal block.

Labeling of 20-Pin Terminal Blocks

Labels for the 20-pin terminal blocks are supplied with the module that you can insert into the terminal block cover.

Each label has 2 sides:

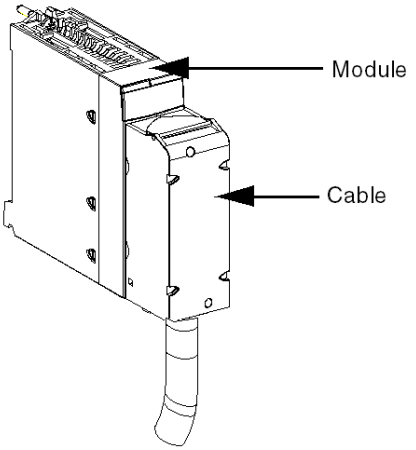
- One side is visible from the outside when the cover is closed. This side features the commercial product references, an abbreviated description of the module, as well as a blank section for customer labeling.
- One side is visible from the inside when the cover is open. This side shows the terminal block connection diagram.

How to Connect HART Analog Input/Output Modules: Connecting 20-pin Terminal Block Modules

Introduction

20-pin connector modules are connected to sensors, pre-actuators or terminals using a cable designed to enable direct wire to wire transition of the module's inputs/outputs.

The following diagram shows the connection of the cable to the module:



⚠ WARNING

UNEXPECTED EQUIPMENT OPERATION

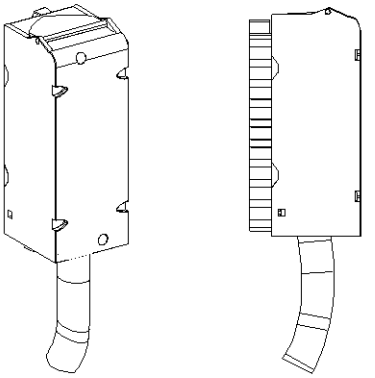
Use only a connector that is designed for a specific module. Plugging the wrong connector can cause an unexpected behavior of the application.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

BMX FTW ••1S Connection Cables

They are made up of:

- At one end, a compound-filled 20-pin connector from which extend 1 cable sheath, containing 20 wires with a cross-sectional area of 0.34 mm^2 (AWG 24),



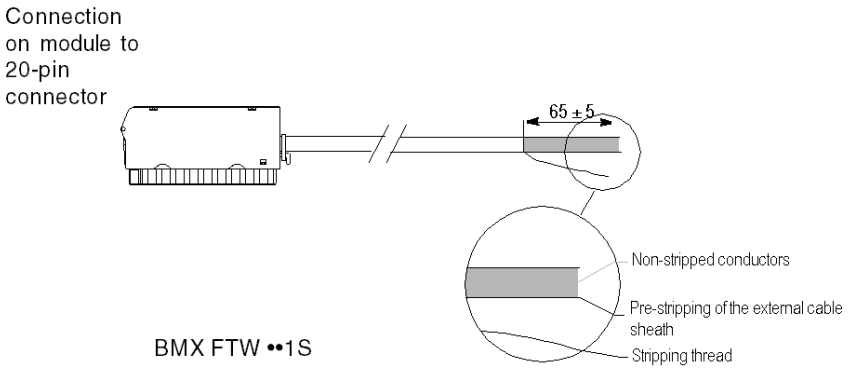
BMX FTW ••1S

- At the other end, free wire ends differentiated by color code.

The cable comes in 2 different lengths:

- 3 meters: BMX FTW 301S;
- 5 meters: BMX FTW 501S;

The figure below shows the BMX FTW ••1S cables:



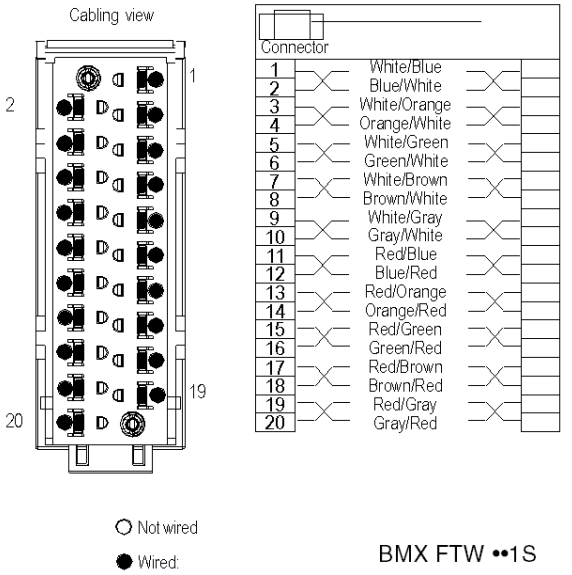
BMX FTW ••1S

NOTE: A strand of nylon incorporated in the cable allows the cable sheath to be stripped with ease.

NOTE: Switch off sensor and pre-actuator voltage before connecting or disconnecting the 20-pin connectors.

Connection of BMX FTW ••1S Cables

The diagram below shows the connection of BMX FTW ••1S cable:



BMX FTW ••1S

TELEFAST Wiring Accessories for the BME AHI 0812 and BME AHO 0412 HART Analog Modules

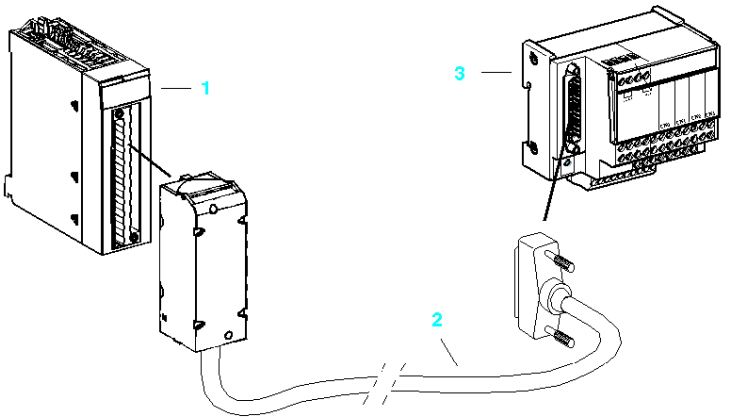
Overview

The following TELEFAST wiring accessories are available for the HART I/O modules:

- For the BME AHI 0812 8-channel analog input module:
  - ABE7-CPA02: 8-channel TELEFAST wiring accessory
  - ABE7-CPA03: 8-channel TELEFAST wiring accessory with non-isolated 24Vdc/25mA power supplies
  - ABE7-CPA31: 8-channel TELEFAST wiring accessory with isolated 24Vdc/25mA power supplies
- For the BME AHO 0412 4-channel analog output module:
  - ABE7-CPA21: 4-channel TELEFAST wiring accessory

Illustration

The HART analog module may be connected to the TELEFAST accessories using a 5-, 3-, or 1.5-meter shielded cable:



1: HART Analog I/O	2: Cable	3: TELEFAST Wiring Accessory
BME AHI 0812	BMX FTA 1522: 1.5 m shielded cable	Any one of: ● ABE7-CPA02 ● ABE7-CPA03 ● ABE7-CPA31
	BMX FTA 3022: 3 m shielded cable	
BME AHO 0412	BMX FCA 150: 1.5 m shielded cable	ABE7-CPA21
	BMX FCA 300: 3 m shielded cable	
	BMX FCA 500: 5 m shielded cable	

Chapter 3
LED Diagnostics

Overview

This chapter describes how to use module LEDs to diagnose the BME AHI 0812 and BME AHO 0412 HART analog I/O.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
LED Diagnostics	30
eX80 Analog I/O Module Diagnostics	31

LED Diagnostics

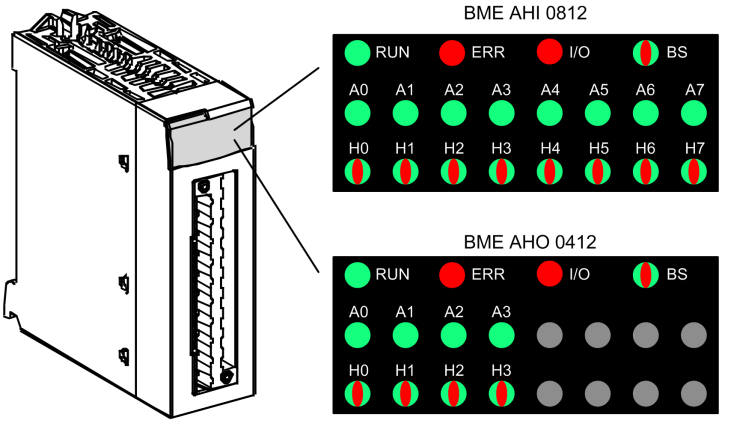
LED Indicators

The BME AHI 0812 and BME AHO 0412 HART eX80 analog I/O modules include LEDs that indicate the operating status of the module:

- module status:
  - RUN (green)
  - ERR (red)
  - I/O (red)
- bus status: BS (red/green)
- analog channel status (green):
  - A0...A7 (for the BME AHI 0812 module)
  - A0...A3 (for the BME AHO 0412 module)
- HART channel status (red/green):
  - H0...H7 (for the BME AHI 0812 module)
  - H0...H3 (for the BME AHO 0412 module)

Illustration

The modules have several LEDs that indicate module operating status:



eX80 Analog I/O Module Diagnostics

LED Diagnostics

Use the combined states of the RUN, ERR, I/O, BS, An and Hn LEDs to diagnose the channel and module status for the BME AHI 0812 and BME AHO 0412 modules:

LED						Description
RUN	**ERR**	**I/O**	**BS**	**A0...An**	**H0...Hn**	
OFF	OFF	OFF	OFF	All OFF	All OFF	Module has no power, or has stopped operating.
BLK green	BLK red	BLK red	BLK red & green	All OFF	All OFF	Module is performing self-test on power-up.
OFF	BLK red	OFF	X	All OFF	All OFF	The module is not yet configured, or is in the process of configuring its channels.
ON green	BLK red	X[1]	X	X	X	No communication between the output module and the head module. **NOTE:** The module retains the previous I/O status.
ON green	OFF	OFF	X	ON green	X	Analog channel is operational.
ON green	OFF	OFF	X	OFF	X	Analog channel is disabled.
ON green	ON red	OFF	X	OFF	X	Analog to digital conversion detected error, or power supply detected error on channel.
ON green	OFF	ON red	X	FLK	X	Overflow or underflow error detected on channel.
ON green	OFF	ON red	X	BLK	X	Broken wired detected on input sensor channel or output actuator channel.
ON green	OFF	ON red	X	OFF	X	Calibration error detected on output channel.
ON green	OFF	ON red	X	X	ON red	No response from HART device on channel.
ON green	OFF	OFF	X	X	BS red	A HART device has been detected with a major difference from the device that is configured for the channel.
ON green	OFF	OFF	X	X	FLK red	A HART device has been detected with a minor difference from the device that is configured for the channel.
ON green	OFF	OFF	X	X	ON green	A HART device has been detected that is the same as the device configured for the channel, or a device with a detected major or minor difference has been accepted.

LED						Description
RUN	**ERR**	**I/O**	**BS**	**A0...An**	**H0...Hn**	
ON green	OFF	OFF	X	X	BLK green	The HART channel is connecting to a device.
ON green	OFF	OFF	X	X	OFF	HART communication disabled for the channel.
BLK green	OFF	OFF	BLK green	X	X	The I/O module is downloading firmware.
X	X	X	OFF	X	X	The module has not been assigned an IP address.
X	X	X	BLK green	X	X	The module has no established EIP Forward Open connections, but has an IP address.
X	X	X	ON green	X	X	The module has established an Ethernet connection.
X	X	X	BLK red	X	X	The module Ethernet connection has timed out. This is cleared only when the timed out connection is re-established or if the module is reset.
OFF	X	X	ON red	X	X	The module has detected that its IP address is already in use.

ON LED is steady on.
OFF LED is off.
FLK Flickering: ON for 50 ms, OFF for 50 ms, repeat.
BLK Blinking: ON for 200 ms, OFF for 200 ms, repeat.
BS Blinking Sequence: ON for 200 ms, OFF for 1,200 ms, repeat.
X This LED is not used in determining the channel or module status.

Chapter 4
BME AHI 0812 HART Analog Input Module

Overview

This chapter describes the BME AHI 0812 HART analog input module for eX80 platforms, and shows you how to connect it to input sensors.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Physical Description	34
BME AHI 0812 Specifications	35
Functional Description	37
Using EMC Kits	41
Wiring Diagrams	44
Using the TELEFAST ABE7-CPA02/03/31 Wiring Accessory	50

Physical Description

Analog plus HART Communication

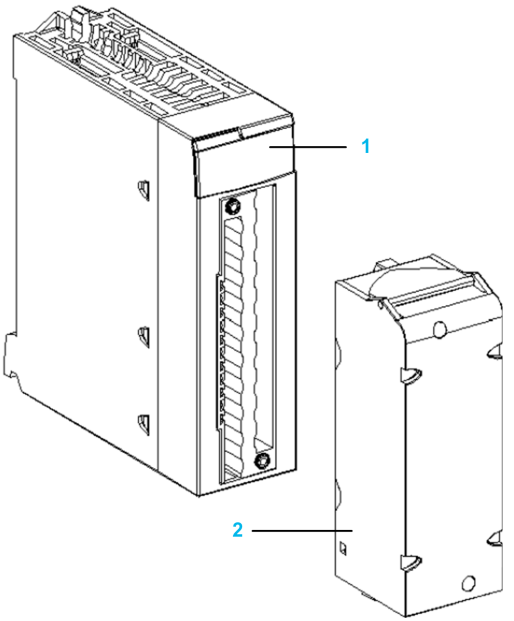
The BME AHI 0812 module is a high-density input module that includes 8 isolated analog channels. Each channel supports HART digital communication.

Use the module with sensors or transmitters. The module uses a 4-20 mA analog signal to perform monitoring and measurement functions.

The module also supports the HART protocol, which superimposes a digital signal on top of the analog signal. The HART digital signal communicates additional instrument information including instrument status, additional process variables, configuration data, and diagnostics.

Illustration

The BME AHI 0812 analog input module with a 20-pin terminal block accessory:



1 LED display
2 20-pin terminal block accessory

NOTE: The terminal block accessory is supplied separately.

BME AHI 0812 Specifications

General Module Specifications

The BME AHI 0812 eX80 HART analog input module possesses the following general characteristics:

Head module compatibility	• Local rack: BME P58 x0x0 CPU • Remote I/O drop: BME CRA 312 10 adapter
Isolation:	–
• between channels	1000 Vdc (1 minute duration)
• between channels and bus	1400 Vdc (1 minute duration)
• between channels and ground	1400 Vdc (1 minute duration)
Operating altitude	0...4000 m
Operating ambient temperature	0...60° C
Vibration	10 mm / 3 g / x10 (per IEC60068-2-6)
Shock	30 g / 11 ms / x3 (per IEC60068-2-27)
Power consumption (3.3V)	0.4 A
Power consumption (24V)	0.04 A
Field device support	2-wire / 4-wire
Maximum overload authorized for inputs	• Voltage: +/– 30 Vdc • Current: +/– 90 mA
Hot-swap support?	Yes

Analog Specifications

The BME AHI 0812 eX80 HART analog input module possesses the following analog characteristics:

Number of channels	8
Type of inputs	High-density isolated fast inputs
Nominal range (full scale)	4-20 mA
Maximum conversion range	0.16...29.92 mA
Measurement accuracy for module:	–
• Accuracy at 25° C	0.15% of full scale[1]
• Accuracy at 0...60° C	0.3% of full scale[1]
Temperature drift	50 ppm / ° C
Display resolution	15-bit plus sign bit
1. Includes conversion resistor detected error. 2. Refresh times are for only the module internal buffer, and are impacted by PLC cycle time.	

Least significant bit weight	0.458 µA
Refresh time:	–
• per module	4 ms[2]
• per channel	4 ms[2]
Response time:	–
• with HART enabled (without digital filter)	50 ms
• with HART disabled (without digital filter)	4 ms
Input impedance	250 Ω
Detection type	broken wire
Monotonicity?	Yes
Crosstalk between channels	≥80 dB
Non-linearity	0.02% of full scale
Repeatability at 25° C of 10 minutes stabilization time	0.01% of full scale
Digital filtering	1st order
1. Includes conversion resistor detected error. 2. Refresh times are for only the module internal buffer, and are impacted by PLC cycle time.	

HART Specifications

The BME AHI 0812 eX80 HART analog input module possesses the following HART characteristics:

HART protocols supported[2]	HART versions 5, 6 and 7
Number of channels	8
Scan time:	–
• Typical[1]	1 s
• Maximum[1]	5 s
Detection time for a non-responsive device	= (scan time) + (timeouts)
HART command system	ARCOM (interface to a HART master)
Topology	Point-to-point
HART I/O mapping?	Yes
1. Scan time is the same for each channel and for the module. The scan time depends on the byte length of the command. The scan time values do not include PLC cycle time, which should be added to determine overall scan time. 2. The eX80 HART input module supports HART up to versions 7.2 and 7.3.	

Functional Description

Introduction

The BME AHI 0812 eX80 HART analog input module supports 4-20 mA analog communication and HART digital communication on each of 8 input channels. The module operates with voltage inputs and includes 8 read resistors connected to the terminal block to convert current inputs.

The eX80 HART analog input module is powered by the backplane.

NOTE: The backplane does not provide power to the 4-20 mA current loop or to any sensor, transmitter, or other device connected to the current loop. You need to provide a source of 24 Vdc power to the current loop, as described in the wiring topic.

Measurement Timing

The BME AHI 0812 eX80 HART analog input module measurement refresh rate is 4 ms. This refresh rate remains constant, no matter how many channels are enabled (or disabled).

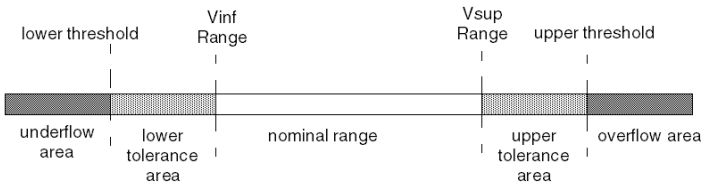
NOTE: The module measurement refresh task is not synchronized with the PLC scan. Therefore, you need to include the PLC scan time when estimating an overall application refresh rate.

Overflow/Underflow Control

Each input on the BME AHI 0812 eX80 HART analog input module operates over a range of 4-20 mA. You can use Unity Pro to map up to 5 current ranges *(see page 97)* for each input.

Upper and lower tolerance detections are enabled regardless of overflow/underflow control.

Depending on the range specified, the module checks for overflow and verifies that the measurement falls between a lower and an upper threshold:



Designation	Description
Nominal range	The specified measurement range
Upper tolerance area	The range of values between the maximum value for the nominal range (20 mA) and the upper threshold
Lower tolerance area	The range of values between the minimum value for the nominal range (4 mA) and the lower threshold
Overflow area	The range of values located above the upper threshold
Underflow area	The range of values located below the lower threshold

NOTE: Monitoring of values in the overflow and underflow area can be enabled or disabled in Unity Pro. Monitoring of the lower and upper tolerance areas is enabled and cannot be disabled.

The values of the thresholds are configurable independently from one another. Both the default values, and the maximum and minimum configurable values are as follows:

Range	BME AHI 0812 Range									
	Underflow Area		Lower Tolerance Area		Nominal Range		Upper Tolerance Area		Overflow Area	
Default setting	–2,400	–801	–800	–1	0	10,000	10,001	10,800	10,801	16,200
Minimum / Maximum	–32,768	...	...	...	...	...	...	...	...	32,767

Measurement Display

Measurements may be displayed using the standard format (in %, to 2 decimal places):

Type of Range	Display
4-20 mA	from 0 to 10,000 (0% to 100%)

It is also possible to define the range of values within which measurements are expressed, by selecting:

- the minimum nominal value corresponding to the minimum value for the range: 0 %.
- the maximum nominal value corresponding to the maximum value for the range (100 %).

The lower and upper thresholds can be integers between –32,768 and +32,767.

For example, imagine a conditioner providing pressure data on a 4-20 mA loop, with 4 mA corresponding to 3,200 millibar and 20 mA corresponding to 9,600 millibar. You have the option of choosing the format, by setting the following lower and upper thresholds:

- 3,200 for 3,200 millibar as the lower threshold
- 9,600 for 9,600 millibar as the upper threshold

In this case, values transmitted to the program vary between 3,200 (= 4 mA) and 9,600 (= 20 mA).

HART Filtering

When the HART function is enabled for the channel, the HART signal is filtered by the low pass filter in the BME AHI 0812 eX80 HART analog input module before being read by the analog input. The 3 dB cut-off frequency is about 10.0 Hz.

Digital Filtering

The type of filtering performed by the system is called *first order filtering*. The filtering coefficient can be modified from a programming console or via the program.

The mathematical formula used is as follows:

$$Meas_{f(n)} = \alpha \times Meas_{f(n-1)} + (1- \alpha) \times Val_{b(n)}$$

α = efficiency of the filter

$Meas_{f(n)}$ = measurement filtered at moment n

$Meas_{f(n-1)}$ = measurement filtered at moment n-1

$Val_{b(n)}$ = gross value at moment n

You may configure the filtering value from 7 possibilities (from 0 to 6). This value may be changed even when the application is in RUN mode.

The filtering values depend on the T configuration cycle (where T = module refresh time):

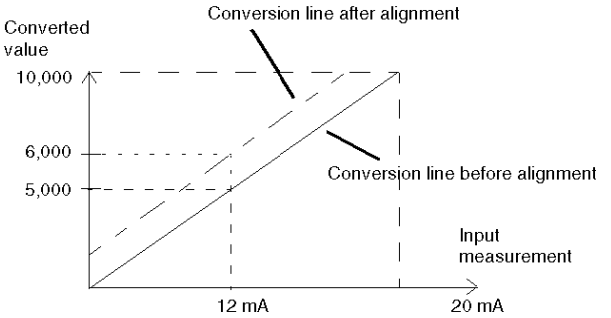
Desired Efficiency	Required Value	Corresponding α	Filter Response Time at 63%	Cut-Off Frequency (in Hz)
No filtering	0	0	0	0
Low filtering	1 2	0.750 0.875	4 x T 8 x T	0.040 / T 0.020 / T
Medium filtering	3 4	0.937 0.969	16 x T 32 x T	0.010 / T 0.005 / T
High filtering	5 6	0.984 0.992	64 x T 128 x T	0.0025 / T 0.0012 / T

NOTE: When HART communication is enabled, operation of both the HART filter and the digital filter may cause excessive latency.

Sensor Alignment

The process of alignment involves the elimination of an observed systematic offset, around a specific operating point, for a given sensor. Sensor alignment compensates for a detected variation that is linked to the process. Replacing a module does not require a new alignment. However, replacing the sensor or changing the sensor operating point requires a new alignment.

Conversion lines are as follows:



The alignment value is editable from a programming console, even if the program is in RUN mode. For each input channel, you can:

- view and modify the desired measurement value
- save the alignment value
- determine whether the channel already has an alignment

The alignment offset may also be modified through programming.

Channel alignment is performed on the channel in standard operating mode, without any effect on the channel operating modes.

The maximum offset between measured value and desired (aligned) value may not exceed +/- 1,500.

NOTE: To align multiple analog channels on the BME AHI 0812 eX80 HART analog input module, proceed channel by channel, aligning one channel at a time. Test each channel after aligning it before proceeding to align the next channel.

Using EMC Kits

Introduction

To help shield the BME AHI 0812 eX80 HART analog input module from electro-magnetic and radio interference, use EMC kits to ground the shielded cables connected to the module.

Cable Shielding

⚠ CAUTION

UNEXPECTED BEHAVIOR OF APPLICATION

To reduce electromagnetic perturbations, use a BMX XSP 0400/0800/1200 EMC kit to connect the shielding.

Electromagnetic perturbations may lead to an unexpected behavior of the application.

Failure to follow these instructions can result in injury or equipment damage.

Connect the cable shielding to the grounding bar. Clamp the shielding to the grounding bar on the module side. Use the following EMC kits to make these connections:

- BMX XSP 0400 EMC kit, for use with the BME XBP 0400 rack
- BMX XSP 0800 EMC kit, for use with the BME XBP 0800 rack
- BMX XSP 1200 EMC kit, for use with the BME XBP 1200 rack

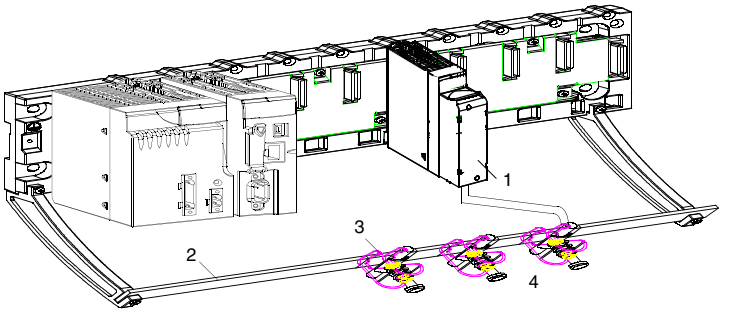
⚠⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

While mounting / removing the modules:

- Confirm that each terminal block is still connected to the shield bar.
- Disconnect voltage supplying sensors and pre-actuators.

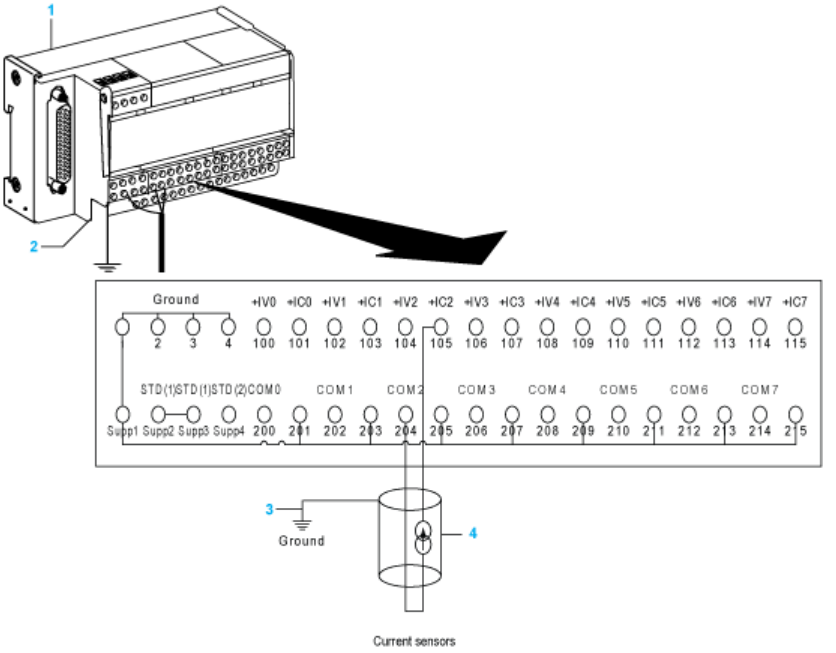
Failure to follow these instructions will result in death or serious injury.



1 BME AHI 0812
2 Shield bar
3 Clamp
4 To sensors

Example of TELEFAST Connection

Connect the sensor cable shielding to the terminals provided and the whole assembly to the cabinet ground.



1 TELEFAST ABE7-CPA02
2 The grounding of cables is facilitated using the ABE7-CPA02 wiring accessory
3 Shield wiring to the ground
4 To current sensors

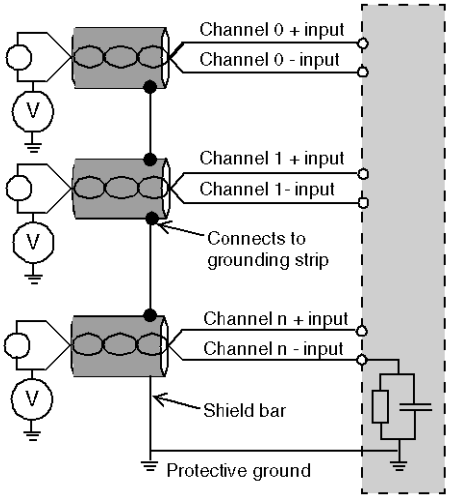
Reference of Sensors in Relation to the Ground

In order for the acquisition system to operate correctly, it is recommended to consider taking the following steps:

- place sensors close together (not more than a few meters apart)
- reference each sensor to a single point, which is connected to the protective ground

Using the Sensors Referenced in Relation to the Ground

The sensors are connected as indicated in the following diagram:



If the sensors are referenced in relation to the ground, this can return a remote ground potential to the terminal block. To help avoid this situation, follow these rules:

- The potential needs to be less than the permitted low voltage of ± 500 Vdc.
- Setting a sensor point to a reference potential generates a leakage current. Check that leakage currents generated do not disturb the system.

NOTE: Sensors and other peripherals may be connected to a grounding point some distance from the module. Such remote ground references may carry considerable potential differences with respect to local ground. Induced currents do not affect the measurement or integrity of the system.

⚠⚠ DANGER

HAZARD OF ELECTRIC SHOCK

Confirm that sensors and other peripherals are not exposed through grounding points to voltage potential greater than acceptable limits.

Failure to follow these instructions will result in death or serious injury.

Wiring Diagrams

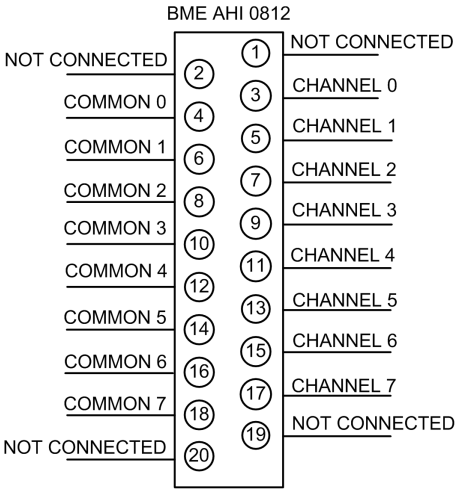
Point-to-Point Connections

The BME AHI 0812 eX80 HART analog input module supports point-to-point 4-20 mA wiring connections to field instruments, including sensors and transmitters. You can make the connection to the input module using a BMX FTB 20x0 20-pin terminal block, or a TELEFAST cable (which includes a 20-pin terminal block).

The input module does not provide 4-20 mA current loop power. You need to include an external power supply in your network that can provide current loop power.

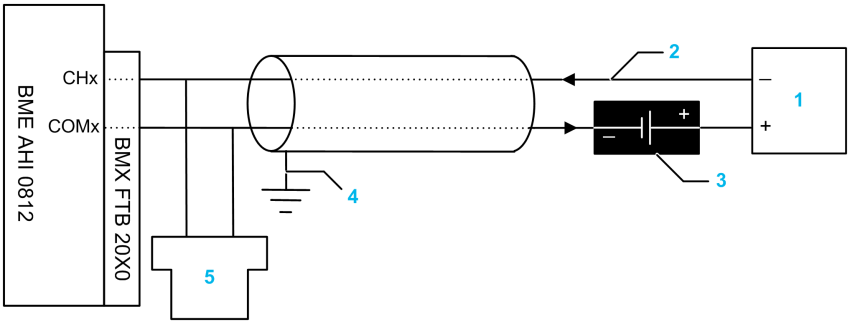
Input Module Pinout

The BME AHI 0812 eX80 HART analog input module present the following 20-pin design, to which you can connect a terminal block or TELEFAST cable:



BME AHI 0812 with 2-Wire Transmitter

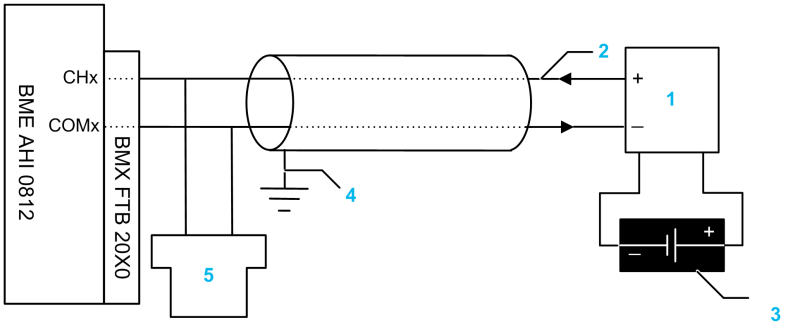
The following illustration shows you how to connect the input module to a 2-wire transmitter. Field power is supplied directly to the 4-20 mA current loop:



1 2-wire transmitter
2 4-20 mA current loop, with arrows indicating direction of current flow
3 Field power supply
4 Protective ground
5 Secondary HART master (hand-held)

BME AHI 0812 with 4-Wire Transmitter

This example illustrates how to connect the input module to a 4-wire transmitter. Field power is provided to the 4-20 mA current loop via the transmitter:



1 4-wire transmitter
2 4-20 mA current loop, with arrows indicating direction of current flow
3 Field power supply
4 Protective ground
5 Secondary HART master (hand-held)

BME AHI 0812 with 2-Wire or 4-Wire Transmitter, TELEFAST Connector with Power Supply

These examples illustrate how to connect the input module to a 2-wire or 4-wire transmitter using a TELEFAST wiring accessory and cable. The cable includes a 20-pin terminal block. 24 Vdc power is supplied to the 4-20 mA current loop:

- via the TELEFAST wiring accessory in the 2-wire design
- via the transmitter in the 4-wire design

NOTE: If you use a TELEFAST ABE7-CPA03 or ABE7-CPA31 wiring accessory to provide 4-20 mA power to the current loop, connect only the ISx and the ICx pins on the TELEFAST wiring accessory. The 0Vx pins are not connected.

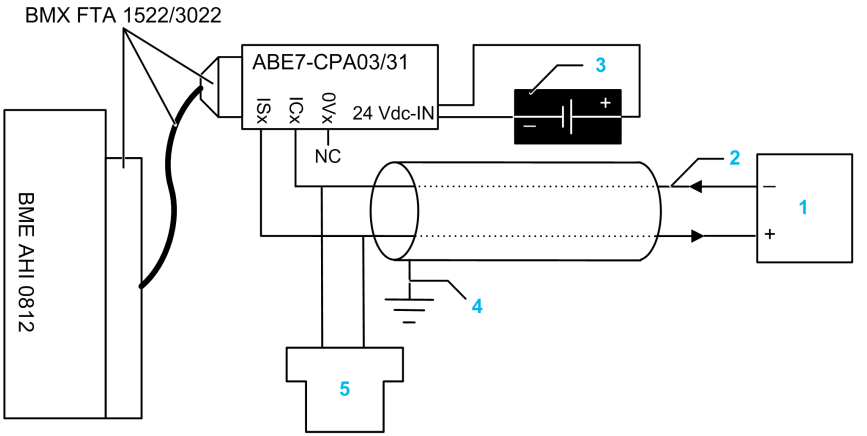
⚠ DANGER

HAZARD OF ELECTRIC SHOCK

Isolation of the channels on the BME AHI 0812 is not preserved when you use the TELEFAST ABE7-CPA03 wiring accessory. Confirm that the protective ground of sensors or transmitters across all the channels are at ground potential. If the electrical potential of sensors or transmitters varies, use ABE7-CPA31 instead of ABE7-CPA03.

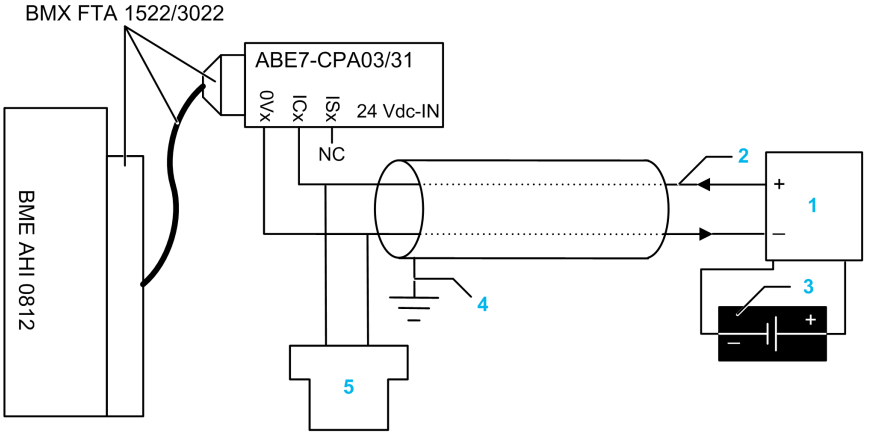
Failure to follow these instructions will result in death or serious injury.

2-wire design:



1 2-wire transmitter
2 4-20 mA current loop, with arrows indicating direction of current flow
3 24 Vdc power supply
4 Protective ground
5 Secondary HART master (hand-held)

4-wire design:



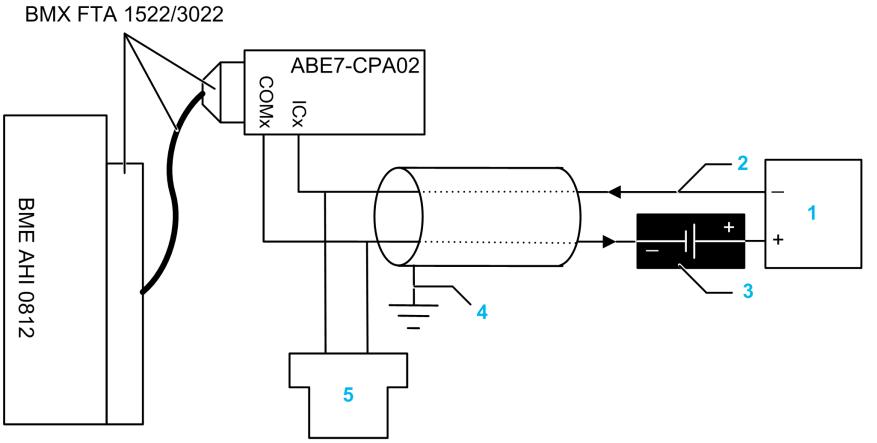
1 4-wire transmitter
2 4-20 mA current loop, with arrows indicating direction of current flow
3 Field power supply
4 Protective ground
5 Secondary HART master (hand-held)

BME AHI 0812 with 2-Wire or 4-Wire Transmitter, TELEFAST Connector without Power Supply

These examples illustrate how to connect the input module to a 2-wire or 4-wire transmitter using a TELEFAST wiring accessory and cable. The cable includes a 20-pin terminal block. Field power is supplied to the 4-20 mA current loop:

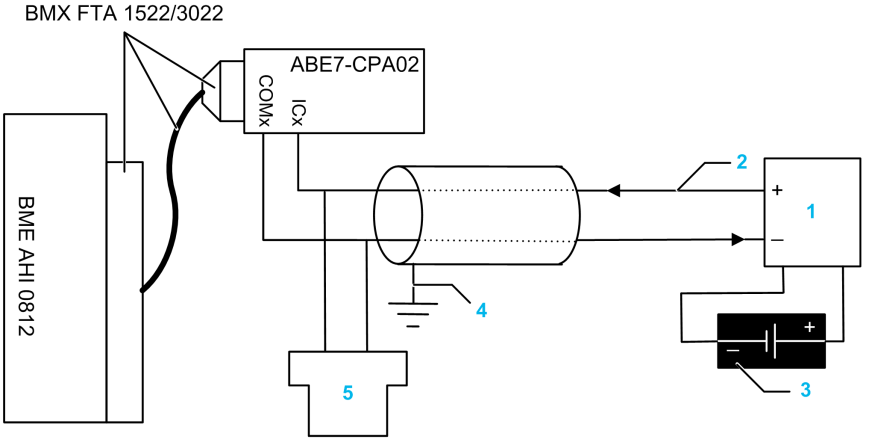
- directly to the current loop in the 2-wire design
- via the transmitter in the 4-wire design

2-wire design:



1 2-wire transmitter
2 4-20 mA current loop, with arrows indicating direction of current flow
3 Field power supply
4 Protective ground
5 Secondary HART master (hand-held)

4-wire design:



1 4-wire transmitter
2 4-20 mA current loop, with arrows indicating direction of current flow
3 Field power supply
4 Protective ground
5 Secondary HART master (hand-held)

HART Network Cable Characteristics and Lengths

The *HART Communication Foundation* has developed documentation describing recommended types and diameters of cable for HART networks. This documentation also includes instructions on how to calculate maximum cable lengths for a HART network.

To obtain a copy of this documentation, visit the *HART Communication Foundation* website at www.hartcomm.org, and download the document *FSK Physical Layer Specification* (document number HFD_SPEC-054). HART network cable characteristics and lengths information can be found at section 7.5 of this document.

For a BME AHI 0812 HART analog input module that uses loop power provided by either a TELEFAST ABE7-CPA03 or ABE7-CPA31 wiring accessory, the maximum cable length between the sensor and wiring accessory is limited by the following calculation (in addition to the maximum cable length limits recommended by the *HART Communication Foundation*:

	ABE7-CPA31	**ABE7-CPA03**
Maximum capacitance	0.206 µF	30.47 nF
Maximum cable length	(0.206 µF) / (Capacitance/unit)	(30.47 nF) / (Capacitance/unit)
Maximum length if Cap/unit = 55pF/feet	3745 ft (1141 m)	554 ft (168 m)

Using the TELEFAST ABE7-CPA02/03/31 Wiring Accessory

Introduction

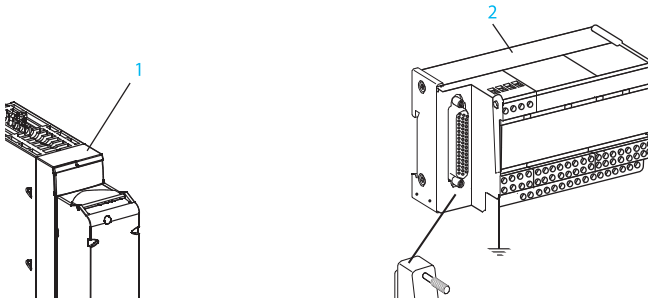
The BME AHI 0812 module can be connected to a TELEFAST ABE7-CPA02/03/31 wiring accessory.

The module is connected to the wiring accessory using one of the following cables:

- BMX FTA 1522: length 1.5 m (4.92 ft)
- BMX FTA 3022: length 3 m (9.84 ft)

Connecting Modules

Modules can be connected to a TELEFAST ABE7-CPA02/03/31 as shown in the diagram below:



1 BME AHI 0812
2 Telefast ABE7-CPA02/03/31
3 Clamp
4 Shield bar
5 BMX FTA 1522/3022

Connecting Sensors

Sensors may be connected to the ABE7-CPA02 accessory *(see page 47)* or to the ABE7-CPA03/31 accessories *(see page 46)* as depicted in the Wiring Diagrams *(see page 44)* topic.

The distribution of analog channels on TELEFAST 2 terminal blocks with the reference ABE7-CPA02 are as follows:

TELEFAST 2 terminal block number	AHI0812 pin out	Signal type	TELEFAST 2 terminal block number	AHI0812 pin out	Signal type
1	NC	Ground	Supp 1	NC	Ground
2	NC	Cable shield	Supp 2	NC	Ground

TELEFAST 2 terminal block number	AHI0812 pin out	Signal type	TELEFAST 2 terminal block number	AHI0812 pin out	Signal type
3	NC	Cable shield	Supp 3	NC	Ground
4	NC	NC	Supp 4	NC	Ground
100	NC	NC	200	4	COM0
101	3	+IC0	201	NC	Ground
102	NC	NC	202	6	COM1
103	5	+IC1	203	NC	Ground
104	NC	NC	204	8	COM2
105	7	+IC2	205	NC	Ground
106	NC	NC	206	10	COM3
107	9	+IC3	207	NC	Ground
108	NC	NC	208	12	COM4
109	11	+IC4	209	NC	Ground
110	NC	NC	210	14	COM5
111	13	+IC5	211	NC	Ground
112	NC	NC	212	16	COM6
113	15	+IC6	213	NC	Ground
114	NC	NC	214	18	COM7
115	17	+IC7	215	NC	Ground

+ICx: + pole current input for channel x
COMx: - Common pin for channel x
NC: Not Connected

⚠ DANGER

HAZARD OF ELECTRIC SHOCK

Confirm that the strap for the ABE7-CPA02 is placed between pin 1 and pin 2. Adjust the strap position if necessary.

Failure to follow these instructions will result in death or serious injury.

NOTE: For the ground connection, use the additional terminal block ABE7-BV10/20/10E/20E.

The distribution of analog channels on TELEFAST 2 terminal blocks with the reference ABE7-CPA03 are as follows:

TELEFAST 2 terminal block number	AHI0812 pin out	Signal type	TELEFAST 2 terminal block number	AHI0812 pin out	Signal type
1	NC	0 Vdc	Supp 1	NC	24 Vdc (sensor supply
2	NC	0 Vdc	Supp 2	NC	24 Vdc (sensor supply
3	NC	0 Vdc	Supp 3	NC	0 Vdc (sensor supply
4	NC	0 Vdc	Supp 4	NC	0 Vdc (sensor supply
100	NC	+IS1	200	NC	+IS0
101	NC	NC	201	NC	NC
102	5	+IC1	202	3	+IC0
103	NC	Ground	203	COMX	0 Vdc
104	NC	+IS3	204	NC	+IS2
105	NC	NC	205	NC	NC
106	9	+IC3	206	7	+IC2
107	NC	Ground	207	COMX	0 Vdc
108	NC	+IS5	208	NC	+IS4
109	NC	NC	209	NC	NC
110	13	+IC5	210	11	+IC4
111	NC	Ground	211	COMX	0 Vdc
112	NC	+IS7	212	NC	+IS6
113	NC	NC	213	NC	NC
114	17	+IC7	214	15	+IC6
115	NC	Ground	215	COMX	0 Vdc
+ICx: + pole current input for channel x +ISx: - pole voltage or current input for channel x COMx: Common pin for channel x NC: Not Connected					

NOTE: Because the 0 VDC pins of ABE7-CPA03 are internally connected, the COMX pins of BMEAHI0812 also are connected when joined with ABE7-CAP03.

For the ground connection, use the additional terminal block ABE7-BV10/20/10E/20E.

The distribution of analog channels on TELEFAST 2 terminal blocks with the reference ABE7-CPA31 are as follows:

TELEFAST 2 terminal block number	AHI0812 pin out	Signal type	TELEFAST 2 terminal block number	AHI0812 pin out	Signal type
1	NC	Ground	Supp 1	NC	+24 Vdc (sensor supply)
2	NC	Ground	Supp 2	NC	+24 Vdc (sensor supply)
3	NC	Ground	Supp 3	NC	0 Vdc (sensor supply)
4	NC	Ground	Supp 4	NC	0 Vdc (sensor supply)
100	NC	+IS0	116	NC	+IS4
101	NC	NC	117	NC	NC
102	3	+IC0	118	11	+IC4
103	4	0 V0	119	12	0 V4
104	NC	+IS1	120	NC	+IS5
105	NC	NC	121	NC	NC
106	5	+IC1	122	13	+IC5
107	6	0 V1	123	14	0 V5
108	NC	+IS2	124	NC	+IS6
109	NC	NC	125	NC	NC
110	7	+IC2	126	15	+IC6
111	8	0 V2	127	16	0 V6
112	NC	+IS3	128	NC	+IS7
113	NC	NC	129	NC	NC
114	9	+IC3	130	17	+IC7
115	10	0 V3	131	18	0 V7

+ICx: + pole current input for channel x
+ISx: - pole voltage or current input for channel x
COMx: Common pin for channel x
NC: Not Connected

NOTE: For the ground connection use the additional terminal block ABE7-BV10/20/10E/20E.

Chapter 5
BME AHO 0412 HART Analog Output Module

Overview

This chapter describes the BME AHO 0412 HART analog output module for eX80 platforms, and shows you how to connect it to actuators.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Physical Description	56
BME AHO 0412 Specifications	57
Functional Description	59
Using EMC Kits	62
Wiring Diagrams	64
Using the TELEFAST ABE7-CPA21 Wiring Accessory	67

Physical Description

Analog plus HART Communication

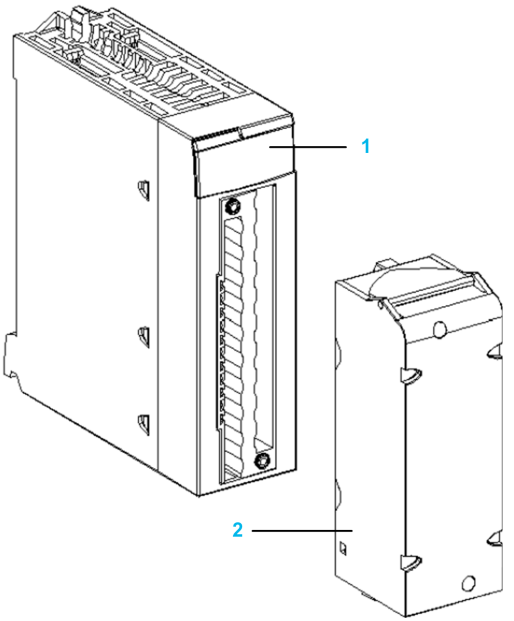
The BME AHO 0412 module is a high-density output module that includes 4 isolated analog channels. Each channel supports HART digital communication.

Use the module with actuators. The module uses a 4-20 mA analog signal to perform continuous process control functions.

The module also supports the HART protocol, which superimposes a digital signal on top of the analog signal. The HART digital signal communicates additional instrument information including instrument status, additional process variables, configuration data, and diagnostics.

Illustration

The BME AHO 0412 analog output module with a 20-pin terminal block accessory:



1 LED display
2 20-pin terminal block accessory

NOTE: The terminal block accessory is supplied separately.

BME AHO 0412 Specifications

General Module Specifications

The BME AHO 0412 eX80 HART analog output module possesses the following general characteristics:

Head module compatibility	• Local rack: BME P58 x0x0 CPU • Remote I/O drop: BME CRA 312 10 adapter
Isolation:	–
• between channels	1000 Vdc (1 minute duration)
• between channels and bus	1400 Vdc (1 minute duration)
• between channels and ground	1400 Vdc (1 minute duration)
Operating altitude	0...4000 m
Operating ambient temperature	0...60° C
Vibration	10 mm / 3 g / x10 (per IEC60068-2-6)
Shock	30 g / 11 ms / x3 (per IEC60068-2-27)
Power consumption (3.3 V)	0.38 A
Power consumption (24 V)	0.14 A
Field device support	2-wire / 4-wire
Hot-swap support?	Yes

Analog Specifications

The BME AHO 0412 eX80 HART analog output module possesses the following analog characteristics:

Number of channels	4
Type of outputs	Current configured by software
Nominal range (full scale)	4-20 mA
Maximum conversion range	0...21 mA
Measurement accuracy for module:	–
• Accuracy at 25° C	0.1% of full scale
• Accuracy at 0...60° C	0.2% of full scale
Temperature drift	45 ppm / ° C
Display resolution	15-bit plus sign bit
Least significant bit weight	0.366 µA
Refresh time:	–
1. Refresh times are for only the module internal buffer, and are impacted by PLC cycle time.	

• per module	2 ms[1]
• per channel	2 ms[1]
Response time:	–
• with HART enabled	20 ms
• with HART disabled	2 ms
Maximum load impedance	• 600 Ω (0...20 mA) • 570 Ω (0...21 mA)
Detection type	broken wire
Monotonicity?	Yes
Non-linearity	0.1% of full scale
1. Refresh times are for only the module internal buffer, and are impacted by PLC cycle time.	

HART Specifications

The BME AHO 0412 eX80 HART analog output module possesses the following HART characteristics:

HART protocols supported[2]	HART versions 5, 6 and 7
Number of channels	4
Scan time:	–
• Typical[1]	1 s
• Maximum[1]	5 s
Detection time for a non-responsive device	= (scan time) + (timeouts)
HART command system	ARCOM (interface to a HART master)
Topology	Point-to-point
HART I/O mapping?	Yes
1. Scan time is the same for each channel and for the module. The scan time depends on the byte length of the command. The scan time values do not include PLC cycle time, which should be added to determine overall scan time. 2. The eX80 HART output module supports HART up to versions 7.2 and 7.3.	

Functional Description

Introduction

The BME AHO 0412 eX80 HART analog output module supports 4-20 mA analog communication and HART digital communication on each of 4 output channels.

Both the eX80 HART analog output module and the 4-20 mA current loop are powered by the backplane.

NOTE: Because the output module passes 24 Vdc power from the backplane to the current loop, an external power supply is not required for the current loop.

Output Slew Rate

When the HART function is enabled, the slew rate of each analog output is automatically limited. As a result, the output slew does not unintentionally trigger the HART receiver.

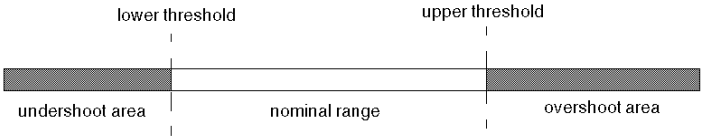
When HART is...	The output slew rate is automatically set to...
Enabled	0,8...0,9 mA/ms
Disabled	• >1500 mA/ms (non-inductive load) • >300 mA/ms (1 mH inductive load)

Overshoot/Undershoot Control

Each output on the BME AHO 0412 eX80 HART analog output module operates over a range of 4-20 mA. You can use Unity Pro to map up to 3 current ranges *(see page 99)* for each output.

Upper and lower tolerance detections are enabled regardless of overflow/underflow control.

Depending on the range specified, the module checks for overflow and verifies that the measurement falls between a lower and an upper threshold:



Designation	Description
Nominal range	The specified measurement range
Overshoot area	The range of values located above the upper threshold
Undershoot area	The range of values located below the lower threshold

NOTE: Monitoring of values in the overshoot and undershoot areas can be enabled or disabled in Unity Pro.

The values of the thresholds are configurable independently from one another. Both the default values, and the maximum and minimum configurable values are as follows:

Range	BME AHO 0412 Range					
	Undershoot Area		Nominal Range		Overshoot Area	
Default setting	–2,500	–801	–8000	10,300	10,301	10,625
Minimum / Maximum	–32,768	...	...	...	...	32,767

Writing Outputs

The application can provide the outputs with values using the standard display (in %, to 2 decimal places):

Type of Range	Display
4-20 mA	from 0 to 10,000 (0% to 100%)

It is also possible to define the range of values within which measurements are expressed, by selecting:

- the minimum nominal value corresponding to the minimum value for the range: 0 %.
- the maximum nominal value corresponding to the maximum value for the range (100 %).

The lower and upper thresholds can be integers between –32,768 and +32,767.

Output Behavior on Program Interruption

In the event the BME AHO 0412 HART analog module detects an event that stops program execution, depending upon the seriousness of the interruption, each of the outputs undertakes one of the following responses:

- apply its fallback/maintain position
- be forced to 0 mA

Output behaviors:

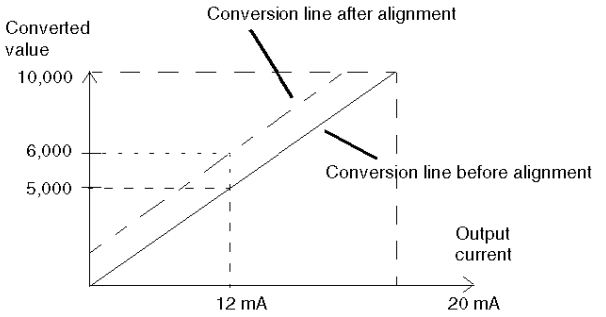
If the detected event is...	The output response is...
Task in STOP mode, or program missing	Fallback/Maintain (channel by channel)
Communication interruption	Fallback/Maintain (channel by channel)
Configuration detected error	0 mA (all channels)
Internal detected error in module	0 mA (all channels)
Output value out of range (undershoot/overshoot)	Value saturated at the defined limit (channel by channel)
Open circuit	Maintain (channel by channel)
Module hot swapping (processor in STOP mode)	0 mA (all channels)

If the detected event is...	The output response is...
Reloading program	0 mA (all channels)
Behavior during initial power-up and power off	0 mA (all channels)

Actuator Alignment

The process of alignment involves the elimination of an observed systematic offset, around a specific operating point, for a given actuator. Actuator alignment compensates for a detected variation that is linked to the process. Replacing a module does not require a new alignment. However, replacing the actuator or changing the actuator operating point requires a new alignment.

Conversion lines are as follows:



The alignment value is editable from a programming console, even if the program is in RUN mode. For each output channel, you can:

- view and modify the desired measurement value
- save the alignment value
- determine whether the channel already has an alignment

The alignment offset may also be modified through programming.

Channel alignment is performed on the channel in standard operating mode, without any effect on the channel operating modes.

The maximum offset between measured value and desired (aligned) value may not exceed +/- 1,500.

NOTE: To align multiple analog channels on the BME AHO 0412 eX80 HART analog output module, proceed channel by channel, aligning one channel at a time. Test each channel after aligning it before proceeding to align the next channel.

Using EMC Kits

Introduction

To help shield the BME AHO 0412 signals from outside interference induced in series mode and interference in common mode, use EMC kits to ground the shielded cables connected to the module.

Cable Shielding

Connect the cable shielding to the grounding bar. Clamp the shielding to the shield bar on the module side. Use the BMX XSP 0400/0800/1200 EMC kit to connect the shielding.

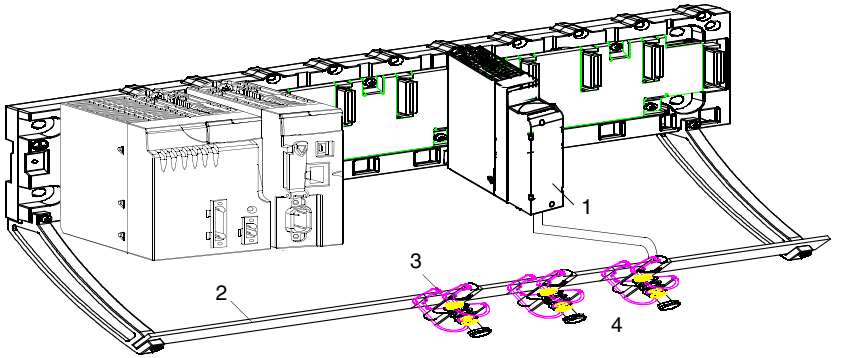
⚠⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

While mounting / removing the modules:

- confirm that each terminal block is connected to the shield bar and
- disconnect voltage supplying sensors and pre-actuators.

Failure to follow these instructions will result in death or serious injury.



1 BME AHO 0412
2 Shield bar
3 Clamp
4 To pre-actuators

Using Pre-Actuators Referenced in Relation to the Ground

There are no specific technical constraints for referencing pre-actuators to the ground. It is nevertheless preferable to avoid returning a remote ground potential to the terminal that may be different to the ground potential close by.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK

Sensors and other peripherals may be connected to a grounding point some distance from the module. Such remote ground references may carry considerable potential differences with respect to local ground. Confirm that:

- potentials greater than safety limits cannot exist,
- induced currents do not affect the measurement or integrity of the system.

Failure to follow these instructions will result in death or serious injury.

Electromagnetic Hazard Instructions

⚠ CAUTION

UNEXPECTED BEHAVIOR OF APPLICATION

To reduce electromagnetic perturbations, use the BMX XSP 0400/0800/1200 EMC kit to connect the shielding without programmable filtering.

Electromagnetic perturbations may lead to an unexpected behavior of the application.

Failure to follow these instructions can result in injury or equipment damage.

Wiring Diagrams

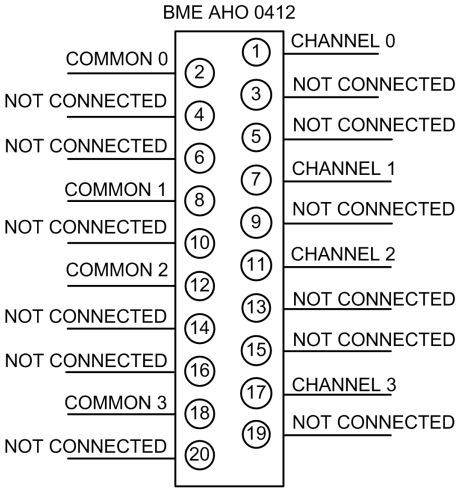
Point-to-Point Connections

The BME AHO 0412 eX80 HART analog output module supports point-to-point 4-20 mA wiring connections to field instruments, including actuators and transmitters. You can make the connection to the output module using a BMX FTB 20x0 20-pin terminal block, or a TELEFAST cable (which includes a 20-pin terminal block).

The output module provides 4-20 mA current loop power.

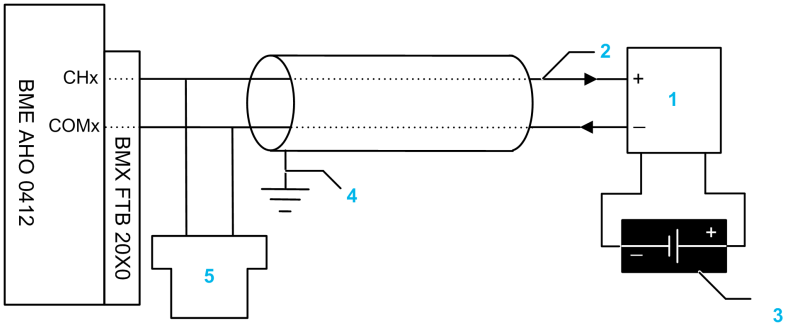
Output Module Pinout

The BME AHO 0412 eX80 HART analog output module present the following 20-pin design, to which you can connect a terminal block or TELEFAST cable:



BME AHO 0412 with 2-Wire or 4-Wire Transmitter

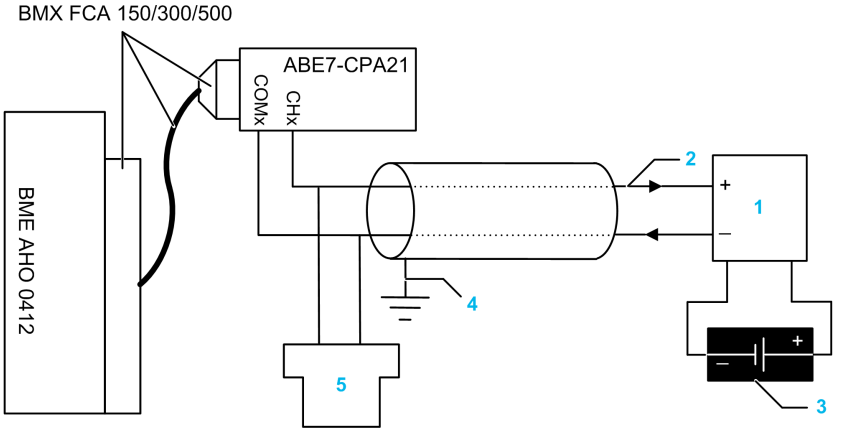
This example illustrates how to connect the output module to a either a 2-wire or a 4-wire transmitter. Field power is provided to the transmitter only in the 4-wire design:



1 2-wire or 4-wire transmitter
2 4-20 mA current loop, with arrows indicating direction of current flow
3 Field power supply (for 4-wire design only)
4 Protective ground
5 Secondary HART master (hand-held)

BME AHO 0412 with 2-Wire or 4-Wire Transmitter, TELEFAST Connector

This example illustrates how to connect the output module to either a 2-wire or a 4-wire transmitter using a TELEFAST wiring accessory and cable. The cable includes a 20-pin terminal block. Field power is supplied to the transmitter only for the 4-wire design.



1 2-wire or 4-wire transmitter
2 4-20 mA current loop, with arrows indicating direction of current flow
3 Field power supply (for 4-wire design only)
4 Protective ground
5 Secondary HART master (hand-held)

HART Network Cable Characteristics and Lengths

The *HART Communication Foundation* has developed documentation describing recommended types and diameters of cable for HART networks. This documentation also includes instructions on how to calculate maximum cable lengths for a HART network.

To obtain a copy of this documentation, visit the *HART Communication Foundation* website at www.hartcomm.org, and download the document *FSK Physical Layer Specification* (document number HFD_SPEC-054). HART network cable characteristics and lengths information can be found at section 7.5 of this document.

Using the TELEFAST ABE7-CPA21 Wiring Accessory

Introduction

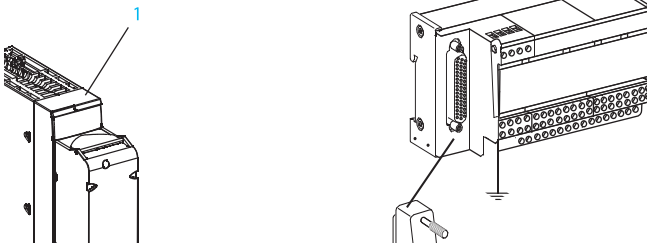
The BME AHO 0412 module can be connected to a TELEFAST ABE7-CPA21 wiring accessory.

The module is connected to the wiring accessory using one of the following cables:

- BMX FCA 150: length 1.5 m (4.92 ft)
- BMX FCA 300: length 3 m (9.84 ft)
- BMX FCA 500: length 5 m (16.40 ft)

Connecting Modules

Modules can be connected to a TELEFAST ABE7-CPA21 as shown in the diagram below:



1 BME AHO 0412
2 TELEFAST ABE7-CPA21
3 Clamp
4 Shield bar
5 BMX FCA 150/300/500

Connecting Sensors

Actuators may be connected to the ABE7-CPA21 wiring accessory as depicted in the Wiring Diagrams *(see page 64)* topic.

The distribution of analog channels on TELEFAST 2 terminal blocks with the reference ABE7-CPA21 are as follows:

TELEFAST 2 terminal block number	AHO0412 pinout	Signal type	TELEFAST 2 terminal block number	AHO0412 pinout	Signal type
1	NC	Ground	Supp 1	NC	Ground
2	NC	Cable shield	Supp 2	NC	Ground
3	NC	Cable shield	Supp 3	NC	Ground
4	NC	Cable shield	Supp 4	NC	Ground
100	1	CH0	200	2	COM0
101	NC	NC	201	NC	Ground
102	7	CH1	202	8	COM1
103	NC	NC	203	NC	Ground
104	11	CH2	204	12	COM2
105	NC	NC	205	NC	Ground
106	17	CH3	206	18	COM3
107	NC	NC	207	NC	Ground
COMx: Common pin for channel x NC: Not connected					

⚠ DANGER

HAZARD OF ELECTRIC SHOCK

Confirm that the strap for the ABE7-CPA21 is placed between pin 1 and pin 2. Adjust the strap position if necessary.

Failure to follow these instructions will result in death or serious injury.

NOTE: For the ground connection, use the additional terminal block ABE7-BV10/20/10E/20E.

Chapter 6
Ethernet Services

Overview

This chapter presents the Ethernet services supported by the BME AHI 0812 and BME AHO 0412 HART analog I/O modules.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Fast Device Replacement	70
Upgrading Firmware	71

Fast Device Replacement

Overview

The fast device replacement (FDR) service employs a central FDR server to store the following parameters for a BME AHI 0812 or BME AHO 0412 analog I/O module:

- IP addressing parameters, and
- Module configuration parameters.

When you replace a module, the server automatically configures the replacement module with the identical parameters as the replaced module. The FDR service removes the need for service personnel to maintain configuration records and reduces the possibility of human error in entering the new configuration.

FDR Server

The M580 Ethernet CPU includes an FDR server. The server is a passive device that stores both IP addressing and configuration parameters for the modules on the network. Each network module is identified by its *device name*. After the FDR service is enabled, the server responds to requests from the FDR clients.

FDR Client

The BME AHI 0812 and BME AHO 0412 analog I/O modules are FDR clients. They use the FDR server to facilitate replacement of the module. Each client is assigned a device name that uniquely identifies it from other modules on the network. After the module is connected to the network, it receives a copy of its operating parameters from the FDR server. These parameter settings enable a replacement module to operate exactly as the original client.

You can use the gateway DTM to send an updated parameter file to the FDR server, where it is stored in Flash memory.

How FDR Works

When it is time to replace a module, the following occurs:

Sequence	Event
1	Your service personnel needs to assign the device name of the original module to the replacement module.
2	Your service personnel places the new module on the network, which is configured to use the DHCP client service.
3	The module automatically sends a request to the server for a set of IP parameters that is used by a module with this device name.
4	The module receives the IP parameters and then connects to the FDR server and downloads a copy of its operating parameters.
5	After the parameters are downloaded, the module implements the parameters and resumes operation.

Upgrading Firmware

Using Unity Loader

Use Unity Loader to install firmware upgrades for the HART analog I/O modules. Unity Loader is a stand-alone utility that ships with your Unity Pro software.

NOTE: Before you can upgrade firmware, you first need to:

- Enable **Firmware upgrade** in the **Security** page for the gateway DTM; then
- With the gateway DTM selected in the **DTM Browser**, click the right mouse button and select the **Device menu** → **Additional functions** → **Transfer to FDR Server** command to update the edited configuration in the FDR server.

Installing Unity Loader

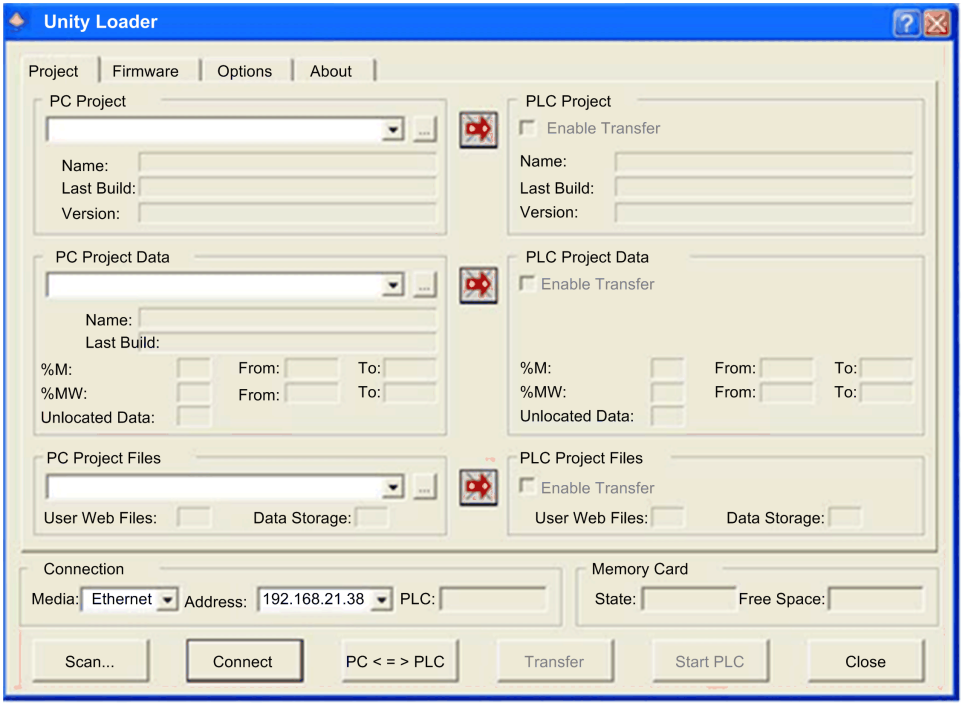
Insert the Unity Loader installation CD in the CD-ROM drive of your maintenance PC. Autorun launches the setup automatically. If not, double-click Setup.exe. The Unity Loader Installation Wizard will guide you through the Unity Loader installation.

Physically Connecting to the Module

After an IP address has been assigned to the module, the next step is to connect your maintenance PC to the module. You can either directly connect your PC to the module, or merely connect your PC to the Ethernet network to which your module is connected.

Connecting Unity Loader to the module

To establish a connection between Unity Loader and the module, follow these steps:

Step	Action	
1	Open Unity Loader on your PC: **Start** → **Programs** → **Schneider Electric** → **Unity Loader**. Unity Loader opens and displays the **Project** tab: 	
2	In the **Connection** part of the page, make the following settings:	
	Media	Select **Ethernet**
	Address	Type in the module IP address. **NOTE:** Confirm that you are using the IP address for the HART I/O module, and not the CPU.
3	Click **Connect**.	

Performing the Upgrade

Before beginning a firmware upgrade, confirm that the module is in Stop mode.

The firmware upgrade for a module is contained in a file with an .LDX extension. The single .LDX file contains the necessary module firmware upgrades.

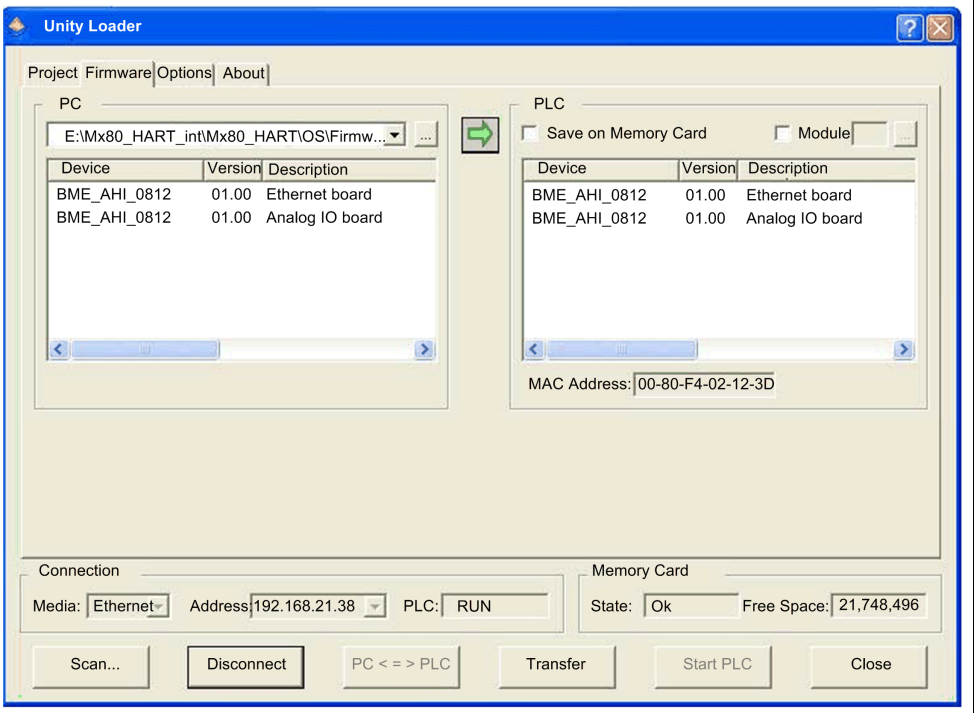
Before upgrading the firmware, Unity Loader confirms that the firmware upgrade file is compatible with your module.

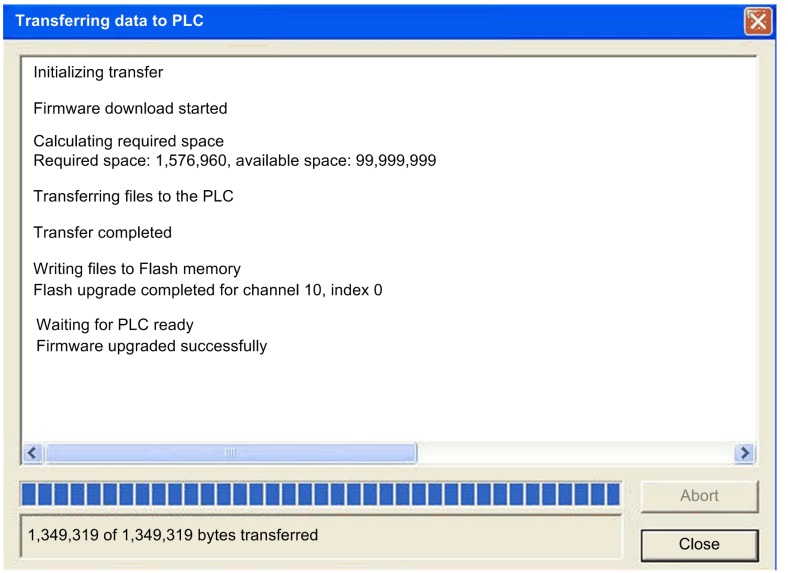
Do not interrupt the firmware download process:

- Do not allow an interruption to the power or the communications during the firmware upgrade process.
- Do not shut down the Unity Loader software during the upgrade.

If the firmware download process is interrupted, the new firmware is not installed and the adapter continues to use the old firmware. If an interruption occurs, cycle power to the HART module and restart the process.

Open Unity Loader on your PC and update the firmware for the remote I/O adapter:

Step	Action
1	After Unity Loader has connected to the module, click the **Firmware** tab.
2	In the **PLC** area of the **Firmware** tab, confirm that the **Module** check-box is de-selected.
3	In the **PC** area, click the ellipsis (**...**) button to open a dialog where you can navigate to and select the firmware file for your module. The firmware is contained in a Unity Loader file (.ldx extension). After you select the firmware file and close the dialog, the selected revision of this firmware is displayed in the list on the left, and the current version of the firmware is displayed in the list on the right. 

Step	Action
4	When the arrow in the middle of the screen (above) is green, click **Transfer**. **NOTE:** Only click **Transfer** if the arrow is green. A yellow arrow indicates that the firmware file on your computer is the same version or newer than the file selected for transfer; a red arrow indicates that the firmware on the computer is not compatible with the module.
5	Click **yes** on the 2 dialogs that appear. A third dialog appears (below), which indicates the transfer status with the blue bars at the bottom of the screen. After the message “Firmware upgraded successfully” is displayed (below), click **Close**. 
6	In the Unity Loader software, click **Disconnect** and close the window. The module reboots itself on completion of the firmware upgrade.

Unity Loader includes its own user documentation. Refer to the *Unity Loader a SoCollaborative Software User Manual* for assistance when you perform the firmware upgrade.

Chapter 7
Introducing HART

Overview

This chapter introduces the *Highway Addressable Remote Transducer* (HART) protocol, and describes the embedded HART multiplexer functionality in both the BME AHI 0812 analog input module and the BME AHO 0412 analog output module.

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
7.1	Introducing the HART Multiplexer	76
7.2	Explicit Messaging Using the DATA_EXCH Block	83

Section 7.1
Introducing the HART Multiplexer

Overview

This section introduces the HART protocol, and describes HART multiplexer communication and commands.

What Is in This Section?

This section contains the following topics:

Topic	Page
Introducing HART	77
HART Multiplexer Communication	79
HART Multiplexer Commands	81

Introducing HART

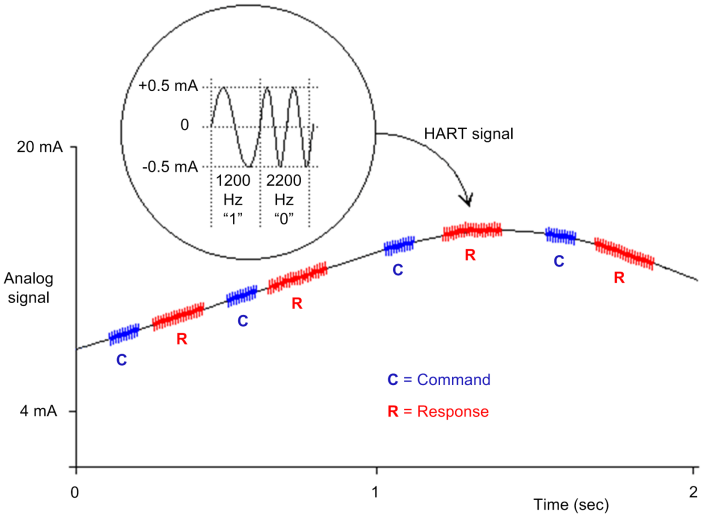
HART

The *Highway Addressable Remote Transducer* (HART) protocol provides digital communication to microprocessor-based analog process control instruments.

HART uses the Bell 202 frequency-shift-keying (FSK) standard to superimpose a digital signal on top of the 4-20mA current loop analog signal:

- the analog signal communicates the primary measured process variable value
- the digital signal communicates additional instrument information including instrument status, additional process variables, configuration data, and diagnostics

The digital signal shifts between a frequency of 1200 Hz (representing a binary 1) and a frequency of 2200 Hz (representing a binary 0):



These digital signal frequencies are higher than the typical analog signaling frequency range of 0...10 Hz. The digital signal is typically isolated using a passive high-pass filter with a cut-off frequency in the range of 400...800 Hz. The analog signal is likewise isolated using a passive low-pass filter.

The separation in frequency between HART and analog signaling allows both signals to coexist on the same current loop. Because the HART digital signal is phase continuous, the HART digital signal:

- does not interfere with the 4-20 mA signal, and
- allows the analog process to continue operating during HART digital communication

Half-duplex Communication Protocol

HART communication is half-duplex in design, which means that a HART-compliant instrument does not simultaneously transmit and receive.

Master - Slave Protocol

HART is a master-slave protocol. A HART-slave responds only when commanded by a HART master. Examples of HART-compliant instruments include:

- HART masters:
  - asset management software (AMS) running on a PC
  - a HART interface module, for example, the HART modem feature of both the BME AHI 0812 input module and the BME AHO 0412 output module when communicating with a HART process control instrument (such as a HART-compliant sensor or actuator)
  - a hand-held device temporarily attached to the network
- HART slaves:
  - a HART process control instrument
  - a HART interface module, for example, the HART modem feature of both the BME AHI 0812 input module and the BME AHO 0412 output module when operating as a slave with asset management software (AMS) or a HART server

HART Multiplexer Communication

Embedded HART Multiplexer

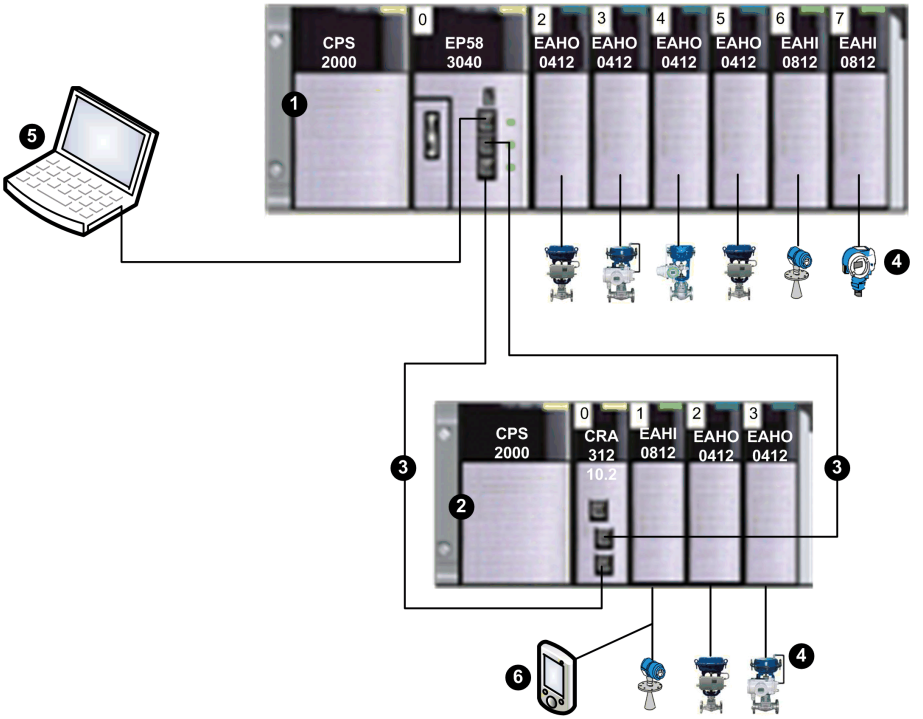
Both the BME AHI 0812 input module and the BME AHO 0412 output module include an embedded HART multiplexer. The multiplexer facilitates the transmission of HART field instrument data by providing:

- one-to-many HART communication between a single HART master and multiple HART field devices, and
- HART instrument data to a PLC master, as part of the periodic scan

HART Primary and Secondary Masters

A HART master can be either:

- a primary master, such as a:
  - configuration PC running Unity Pro, or asset management software
  - PC running SCADA as HART server
- a secondary master, such as a hand-held device that can be temporarily connected directly to the current loop between an I/O module and the HART field instrument



1 Local rack containing a BME P58 3040 CPU with remote I/O scanning service
2 Remote I/O rack containing a BME CRA 312 10 adapter module
3 Remote I/O main ring
4 HART-enabled field instruments connected to I/O via 4-20 mA current loop wiring
5 Maintenance PC operating as HART primary master (running, for example, Unity Pro configuration software or asset management software) or SCADA
6 Hand-held HART secondary master

The HART multiplexer supports one HART field instrument per I/O channel.

HART Multiplexer Commands

Overview

The HART multiplexer within the HART analog I/O modules support the following HART multiplexer commands.

Universal Commands

Command	Description
1	Read primary variable
2	Read loop current and percentage of range
3	Read dynamic variables and loop current
6	Write polling address
7	Read loop configuration
8	Read dynamic variable classifications
9	Read device variables with status
11	Read unique identifier associated with tag
12	Read message
13	Read tag, descriptor, and date
14	Read primary variable transducer information
15	Read device information
16	Read final assembly number
17	Write message
18	Write tag, descriptor, and date
19	Write final assembly number
20	Read long tag
21	Read unique identifier associated with long tag
22	Write long tag
38	Reset configuration changed flag
48	Read additional device status

Common Practice Commands

Command	Description
42	Perform device reset
59	Write number of response preambles
106	Flush delayed response

ARCOM Multiplexer Common Practice Commands

Command	Description
128	Read parameters
129	Read loop status
130	Read instrument list from index
131	Read instrument static data
132	Write instrument static data
133	Remove instrument from instrument list
134	Read scan list from index
135	Read instrument dynamic data
136	Read instrument scan status
137	Write instrument scan status
138	Read instrument cumulative responses
139	Reset instrument cumulative responses
140	Read instrument tries and failures
141	Reset instrument tries and failures
142	Read counts of host communications
143	Reset counts of host communications
144	Read retry limits
145	Write retry limits
146	Read scan command
147	Write scan command
148	Read scan status
149	Write scan status
150	Read gender
151	Write gender
152	Read loop search type
153	Write loop search type
154	Rebuild loops
155	Copy command and reply (pass-through)

Section 7.2
Explicit Messaging Using the DATA_EXCH Block

Overview

This section introduces you to the DATA_EXCH function block, which you can use to configure explicit messages containing HART requests.

What Is in This Section?

This section contains the following topics:

Topic	Page
Configuring Explicit Messaging Using DATA_EXCH	84
Configuring EtherNet/IP Explicit Messaging Using DATA_EXCH	86
Configuring the DATA_EXCH Management Parameter	87
Configuring EtherNet/IP Explicit Messaging Using DATA_EXCH	88
Viewing the DATA_EXCH Received_Data Parameter	89

Configuring Explicit Messaging Using DATA_EXCH

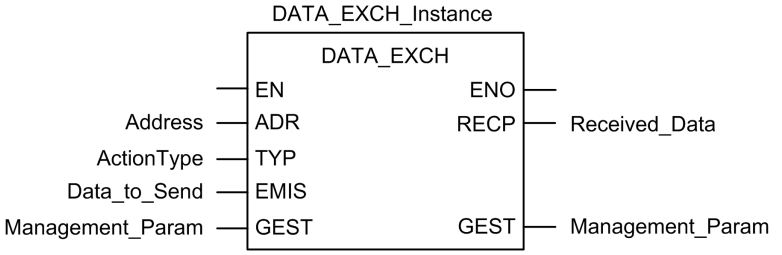
Overview

Use the DATA_EXCH function block to configure EtherNet/IP connected and unconnected explicit messages.

The Management_Param, the Data_to_Send, and the Received_Data parameters define the operation.

EN and ENO can be configured as additional parameters.

FBD Representation



Input Parameters

Parameter	Data type	Description
Address	Array [0...7] of INT	The path to the destination device, the content of which can vary depending on the message protocol. Use the ADDM function.
ActionType	INT	The type of action to perform. This setting = 1 (transmission followed by await reception).
Data_to_Send	Array [n...m] of INT	The EtherNet/IP and CIP request codes that define the type of message to send, plus any data that needs to be included with the request. Refer to the to the topic Configuring the Data_To_Send Parameter *(see page 88)*.

Input/Output Parameters

Parameter	Data type	Description
Management_Param	Array [0...3] of INT	The management parameter *(see page 87)*, consisting of 4 words.

Output Parameters

Parameter	Data type	Description
`Received_Data`	Array [n...m] of `INT`	The EtherNet/IP response *(see page 89)*.

Configuring EtherNet/IP Explicit Messaging Using DATA_EXCH

Configuring the Address Parameter

To configure the Address parameter, use the ADDMX function to convert the character string, described below, to an address:

ADDMX('rack.slot.channel{ip_address}message_type.protocol'), where:

Field	Description	Setting
rack	The number assigned to the rack containing the communication module.	Application specific
slot	The position of the communication module in the rack.	Application specific
channel	The communication channel.	3
ip_address	The IP address of the BME AHI 0812 or BME AHO 0412.	Application specific
message_type	The type of message, presented as a three character string: • **UNC** (indicating an unconnected message), or • **CON** (indicating a connected message)	UNC
protocol	The protocol type.	CIP

Configuring the DATA_EXCH Management Parameter

Configuring the Management Parameter

The Management parameter consists of 4 contiguous words, described below:

Data source	Register	Description	
		High Byte (MSB)	Low Byte (LSB)
Data managed by the system	`Management_Param[0]`	Exchange number	Two read-only bits: ● Bit 0 = Activity bit (see below) ● Bit 1 = Cancel bit
	`Management_Param[1]`	Operation report *(see page 217)*	Communication report *(see page 216)*

Data managed by the user	`Management_Param[2]`	Block timeout. Values include:
		● 0 = infinite wait
		● other values = timeout x 100 ms, for example:
		  ● 1 = 100 ms
		  ● 2 = 200 ms	

	`Management_Param[3]`	Length of data sent or received: ● Input (before sending the request): length of data in the `Data_to_Send` parameter, in bytes ● Output (after response): length of data in the `Received_Data` parameter, in bytes	

Activity Bit:

This bit indicates the execution status of the communication function.

It is set to 1 when launched, and returns to 0 when its execution is complete.

It is the first bit of the first element of the table.

Example: if the management table has been declared as follows:

`Management_Param[0] ARRAY [0..3] OF INT`,

the activity bit is the bit with the notation `Management_Param[0].0`.

NOTE: The notation previously used requires configuration of the project properties in such a way as to authorize the extraction of bits on integer types. If this is not the case, `Management_Param[0].0` cannot be accessed in this manner.

Configuring EtherNet/IP Explicit Messaging Using DATA_EXCH

Configuring the Data_to_Send Parameter

The `Data_to_Send` parameter varies in size. It consists of contiguous registers that include—in sequence—both the message type and the CIP request:

Variable	Byte Offset	Data Type	Description	Value
DataToSend[0]	0	Bytes	Message type: ● High byte = size of the request in words: 16#03 hex (3 decimal) ● Low byte = EtherNet/IP service code: 16#4B (75 decimal)	16#034B
DataToSend[1]	2	Bytes	CIP request class information - Class Segment: ● High byte = 16#00 hex (0 decimal) ● Low byte = 16#21 (33 decimal)	16#0021
DataToSend[2]	4	Bytes	CIP request class information - class: ● High byte = 16#04 hex (4 decimal) ● Low byte = 16#10 (16 decimal)	16#0410
DataToSend[3]	6	Bytes	CIP request instance information: ● High byte = instance: 16#01 (1 decimal) ● Low byte = instance segment: 16#24 (36 decimal)	16#0124
DataToSend[4...n]	8	Bytes	HART request (see below)	–

The HART request consists of the following fields:

Byte Offset	Field	Data Type	Description
8	Delimiter	Byte	Indicates the position of the byte count and frame type.
9 or 9...13	Address	Byte or bytes	Short address or long address.
10 or 14	Command	Bytes	CIP request class information - class: ● High byte = 16#04 hex (4 decimal) ● Low byte = 16#10 (16 decimal)
11 or 15	Byte Count	Byte	Represents the number of data bytes in this request.
12...n or 16...n	Data	Byte array[1]	(Optional) Application layer data.
1. Each array entry presents 2 bytes of data in little endian format, where the least significant byte is stored in the smallest memory address.			

Refer to Token-Passing Data Link Layer Specification, Universal Command Specification and Arcom Multiplexer Specification.

Viewing the DATA_EXCH Received_Data Parameter

Contents of the Received_Data Parameter

The `Received_Data` parameter contains only the EtherNet/IP response. The length of the response varies, and is reported by `Management_Param[3]` after the response is received. The format of the response is described, below:

Byte Offset	Field	Data Type	Description
0	Reply Service	Byte	Service of the explicit message + 16#80
1	<Reserved>	Byte	–
2	General Status	Byte	Ethernet/IP general status
3	Size of Additional Status	Byte	Additional Status array size, in words
4	Additional Status	Word array	Additional status
5	Response Data[1]	Word array	Response data from request, or additional detected error data if General Status indicates a detected error.
1. The response is structured in little endian order.			

NOTE: Refer to *The CIP Networks Library, Volume 1, Common Industrial Protocol* at section 3-5.6 *Connection Manager Object Instance Error Codes*.

Chapter 8
Configuring BME AHI 0812 and BME AHO 0412 Modules in Unity Pro

Overview

This chapter describes how to add a HART analog I/O module to the **PLC Bus**, and then configure the module using dialogs you can access from the **PLC Bus**.

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
8.1	Adding and Configuring HART Analog I/O	92
8.2	Configuring X80 Analog Device DDT Parameters	101

Section 8.1
Adding and Configuring HART Analog I/O

Overview

This section describes how to add a HART analog I/O module to the **PLC Bus**, and then configure the module using Unity Pro screens that you can access from the **PLC Bus**.

What Is in This Section?

This section contains the following topics:

Topic	Page
Creating a New M580 Project in Unity Pro	93
Adding HART Analog I/O Modules to the Project	94
Configuring Analog Input Channels for the BME AHI 0812	97
Configuring Analog Output Channels for the BME AHO 0412	99

Creating a New M580 Project in Unity Pro

Creating the New Project

When you open Unity Pro, follow these steps to create a new project:

Step	Action
1	Select **File** → **New**. The **New Project** dialog opens.
2	In the **PLC** area, expand the **Modicon M580** node and select a BME P58 x040 CPU.
3	In the **Rack** area, expand **Modicon M580 local drop** → **Rack** and select a BME XBP xx00 backplane.
4	Click **OK** to save your selections.
5	In the **Project Browser**, navigate to then double-click **Project** → **Configuration** → **0 : PLC Bus**. The **PLC Bus** window opens, displaying the selected rack, CPU, and default power supply module.

You can now add modules to the local main rack.

Adding a Remote Rack to the Project

If your project will include both a local and a remote rack, follow these steps to create the remote rack:

Step	Action
1	In the **Project Browser**, navigate to then double-click **Project** → **Configuration** → **2: EIO Bus**. The **EIO Bus** window opens, displaying an empty rectangle.
2	Double-click on the rectangle. The **New Device** window opens, displaying 2 lists.
3	In the **Drop end communication** list, select one of the BMX CRA adapter modules.
4	Click **OK** to save your selections.
5	The **EIO Bus** window now displays the selected rack, with the selected BMX CRA adapter module placed in slot 0.
5	Place your cursor over an empty slot to the left of the BMX CRA adapter module, click the right mouse button, then select **New Device...**. The **New Device** window opens.
6	In the **New Device** window, select a power supply for the remote rack, then click **OK**. The **EIO Bus** window now displays the selected BMX CRA adapter and power supply.

You can now add modules to the remote main rack.

Adding HART Analog I/O Modules to the Project

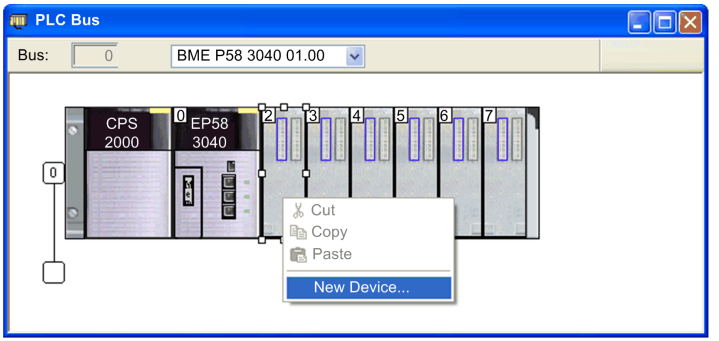
Before You Begin

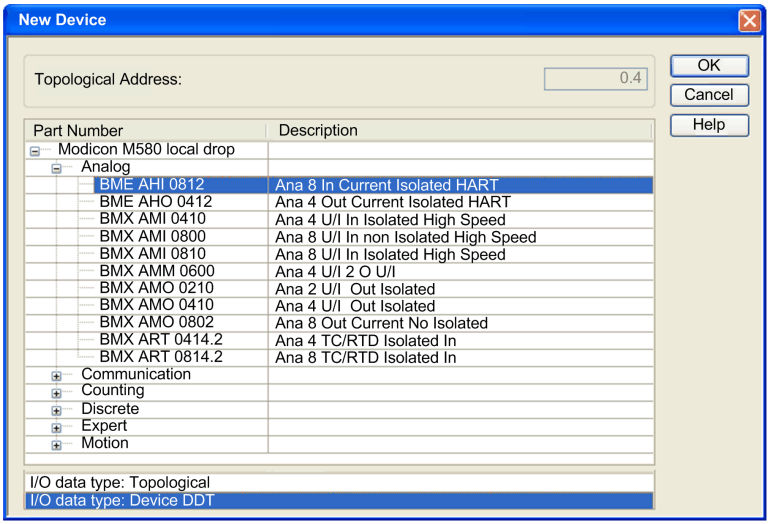
You can add a BME AHI 0812 input module or a BME AHO 0412 output module only to a main rack that includes a BME XBP xx00 Ethernet backplane. If that rack is:

- a local main rack, it needs to include a BME P58 x040 Ethernet CPU
- a remote main rack, it needs to include a BME CRA 312 10 adapter

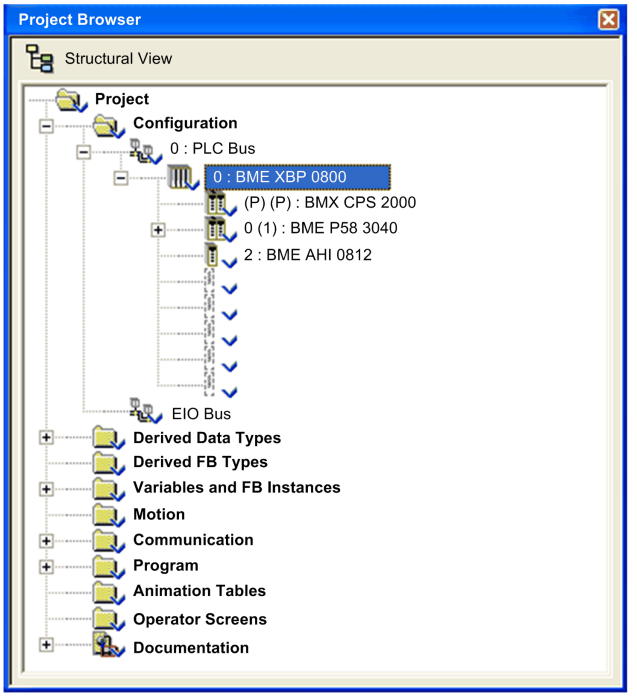
Adding a New HART Analog I/O Module

To add a new HART analog I/O module to the project, follow these steps:

Step	Action
1	In the **Project Browser**, right click the **PLC Bus** node, and then select **Open** from the context menu. The **PLC Bus** opens. In the **Project Browser**: ● to add a module to the local rack, right click the **PLC Bus** node, and then select **Open** from the context menu. ● to add a module to a remote rack, right click the **EIO Bus** node, and then select **Open** from the context menu. The selected bus opens.
2	In the **PLC Bus**, right-click in a slot where you want to insert a HART analog I/O module. A context menu opens:  **NOTE:** In this example, modules are added to the **PLC Bus**.

Step	Action
3	Select **New Device...**. The **New Device** dialog opens: 

4	In the **New Device** dialog, make the following selections:
	● Select a HART analog I/O module (in this example, a BME AHI 0812 input module); then
	● For this local rack, select the I/O data type for your module, either:
	  ● Topological: supports only analog data
	  ● Device DDT (default): supports both analog and HART data
	NOTE: For a remote rack, Device DDT is pre-selected.

Step	Action
5	Click **OK**. The selected module is added to the **PLC Bus** and to the **Project Browser** (below):  **NOTE:** If you add a module to the remote rack, it appears beneath **EIO Bus**.
6	In the **PLC Bus** window, double-click on the Ethernet ports of the CPU. The **RIO DIO Communicator Head** window opens.
7	In the **Security** tab, make the following selections: ● FTP: select Enabled, to permit configuration transfers between the CPU and modules on the main rack. ● TFTP: select Enabled, to permit configuration transfers between the CPU and modules on a remote rack.
8	In the **Edit** toolbar, click the **Validate** ( ) button.

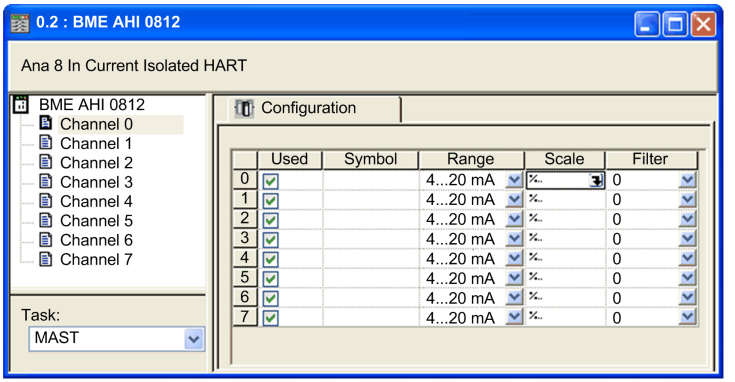
To configure the HART analog I/O module, right-click on the module in the **Project Browser**, and then select **Open**.

NOTE: In addition to configuring the HART analog I/O module, you also need to add and configure the HART analog I/O module DTM *(see page 105)*.

Configuring Analog Input Channels for the BME AHI 0812

Analog Input Channels

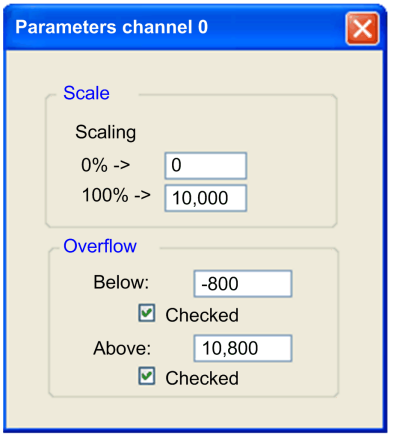
The BME AHI 0812 HART analog input module includes 8 input channels. To open the module for configuration in Unity Pro, double-click the input module in the **PLC Bus**:



Channel Parameters

To configure an input channel, select that channel on the left side of the configuration dialog. You can edit the following parameters for each of the 8 channels:

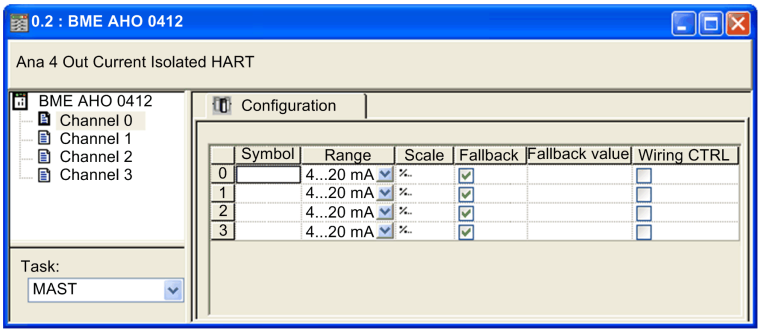
Parameter	Description
Used	The status of the channel: ● Selected = enabled (default) ● De-selected = disabled
Symbol	(Read only) Displays the variable that has been associated with this channel.
Range	(Read only) Displays the current loop range of 4...20 mA.

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td>Scale</td><td colspan="2">Click in this field to open the following dialog where you can input the following scaling and overflow (see page 37) parameters:
 
</td></tr>
<tr><td></td><td>Scaling: 0%:</td><td>Input the percentage scaling value for 4 mA current (default = 0).</td></tr>
<tr><td></td><td>Scaling: 100%:</td><td>Input the percentage scaling value for 20 mA current (default = 10,000).</td></tr>
<tr><td></td><td>Overflow: Below</td><td>The threshold between the lower tolerance area and the underflow area (default = –800).</td></tr>
<tr><td></td><td>Overflow: Below (checkbox)</td><td>The status of underflow control:
● Selected = enabled (default)
● De-selected = disabled</td></tr>
<tr><td></td><td>Overflow: Above</td><td>The threshold between the upper tolerance area and the overflow area (default = 10,800).</td></tr>
<tr><td></td><td>Overflow: Above (checkbox)</td><td>The status of overflow control:
● Selected = enabled (default)
● De-selected = disabled</td></tr>
<tr><td>Filter</td><td colspan="2">The Required Value used to perform first order filtering of the analog signal (see page 39). Values include:
● 0: no filtering
● 1, 2: low filtering
● 3, 4: medium filtering
● 5, 6: high filtering</td></tr>
</table>

Configuring Analog Output Channels for the BME AHO 0412

Analog Output Channels

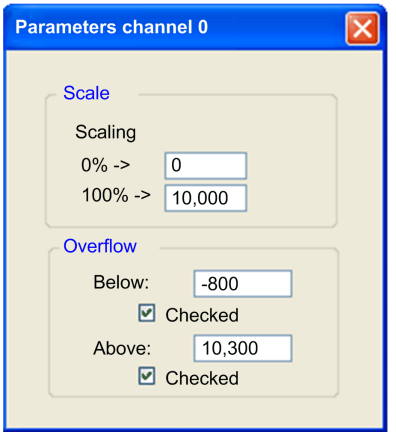
The BME AHO 0412 HART analog output module includes 4 output channels. To open the module for configuration in Unity Pro, double-click the output module in the **PLC Bus**:



Channel Parameters

To configure an output channel, select that channel on the left side of the configuration dialog. You can edit the following parameters for each of the 4 channels:

Parameter	Description
Symbol	(Read only) Displays the variable that has been associated with this channel.
Range	(Read only) Displays the current loop range of 4...20 mA.

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td>Scale</td><td colspan="2">Click in this field to open the following dialog where you can input scaling and overflow (see page 37) parameters:
 
</td></tr>
<tr><td></td><td>Scaling: 0%:</td><td>Input the percentage scaling value for 4 mA current (default = 0).</td></tr>
<tr><td></td><td>Scaling: 100%:</td><td>Input the percentage scaling value for 20 mA current (default = 10,000).</td></tr>
<tr><td></td><td>Overflow: Below</td><td>The threshold between the lower tolerance area and the underflow area (default = –800).</td></tr>
<tr><td></td><td>Overflow: Below (checkbox)</td><td>The status of underflow control:
● Selected = enabled (default)
● De-selected = disabled</td></tr>
<tr><td></td><td>Overflow: Above</td><td>The threshold between the upper tolerance area and the overflow area (default = 10,300).</td></tr>
<tr><td></td><td>Overflow: Above (checkbox)</td><td>The status of overflow control:
● Selected = enabled (default)
● De-selected = disabled</td></tr>
<tr><td>Fallback</td><td colspan="2">Use this checkbox to specify the behavior of the output when the PLC is in STOP mode or if communication between the PLC and the output module has stopped:
● Selected: the value specified in the Fallback Value parameter is assigned to the output.
● De-selected: the output maintains its value.</td></tr>
<tr><td>Fallback value</td><td colspan="2">If the Fallback parameter is selected, this value is assigned to the output on fallback. The range of available values is defined by the 0%...100% scaling settings.</td></tr>
<tr><td>Wiring Ctrl</td><td colspan="2">The wiring control function checks for a broken wire. Use the checkbox to activate and de-activate wiring control, as follows:
● Selected = wiring control is enabled
● De-selected = wiring control is disabled (default)</td></tr>
</table>

Section 8.2
Configuring X80 Analog Device DDT Parameters

Overview

This section describes how to configure an X80 analog I/O module DDT parameters, where the module is placed in a remote I/O drop.

What Is in This Section?

This section contains the following topics:

Topic	Page
Device DDT Parameters for the BME AHI 0812	102
Device DDT Parameters for the BME AHO 0412	103

Device DDT Parameters for the BME AHI 0812

Device DDT Parameters (Remote I/O Drop)

This topic describes the Unity Pro **Device DDT** tab for a BME AHI 0812 HART analog input module, which is placed in an Ethernet remote I/O drop that includes a BME CRA 312 10 adapter module. A derived data type (DDT) is a set of elements with the same type (ARRAY) or with different types (structure).

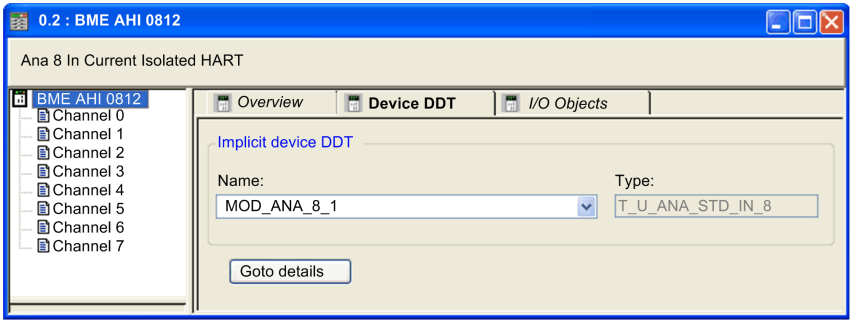
NOTE: These instructions assume that you have already added a drop to your Unity Pro project.

Access the Device DDT Tab

Access the **Device DDT** parameters in Unity Pro:

Step	Action
1	In the **PLC Bus**, double-click the BME AHI 0812 HART analog input module. The module configuration window opens.
2	Select the **Device DDT** tab.

The **Device DDT** tab contains a name and a type:



Parameters

Use the Unity Pro **Device DDT** tab to configure these parameters for the analog I/O module on the remote I/O rack:

Parameter	Description
Name	The default device DDT instance name is MOD_ANA_8_x (where *x* equals the module number).
Type	The module type (read-only).
Goto details	Links to the DDT data editor.

Device DDT Parameters for the BME AHO 0412

Device DDT Parameters (Remote I/O Drop)

This topic describes the Unity Pro **Device DDT** tab for a BME AHO 0412 HART analog output module, which is placed in an Ethernet remote I/O drop that includes a BME CRA 312 10 adapter module. A derived data type (DDT) is a set of elements with the same type (ARRAY) or with different types (structure).

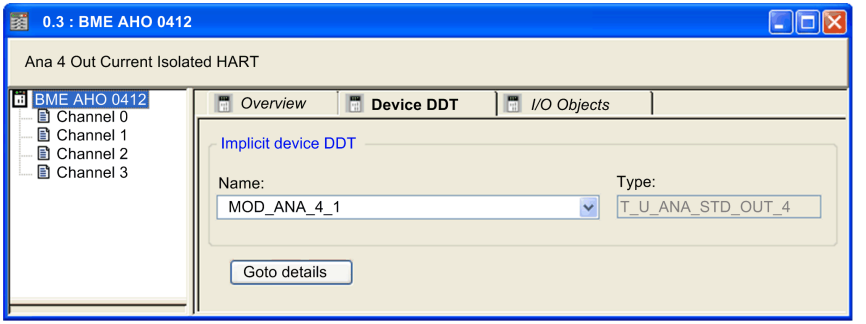
NOTE: These instructions assume that you have already added a drop to your Unity Pro project.

Access the Device DDT Tab

Access the **Device DDT** parameters in Unity Pro:

Step	Action
1	In the **PLC Bus**, double-click the BME AHO 0412 HART analog input module. The module configuration window opens.
2	Select the **Device DDT** tab.

The **Device DDT** tab contains a name and a type:



Parameters

Use the Unity Pro **Device DDT** tab to configure these parameters for the analog I/O module on the remote I/O rack:

Parameter	Description
Name	The default device DDT instance name is MOD_ANA_4_x (where *x* equals the module number).
Type	The module type (read-only).
Goto details	Links to the DDT data editor.

Chapter 9
Configuring BME AHI 0812 and BME AHO 0412 DTMs

Overview

This chapter describes how to add a HART analog I/O module DTM to the **DTM Browser** for a new module, and then configure that DTM using dialogs you can access from the **DTM Browser**.

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
9.1	Adding a Module DTM	106
9.2	Configuring the Module IP Address	110
9.3	Configuring the Module DTM	115
9.4	Completing the Project Configuration	141
9.5	Working with Field Instrument Management Tools	151

Section 9.1
Adding a Module DTM

Adding a DTM to the DTM Browser

Overview

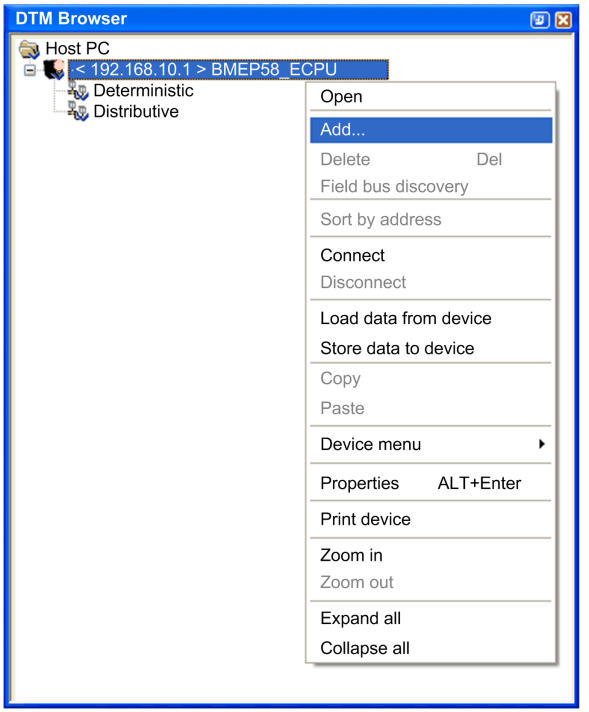
In addition to adding a module to the PLC Bus *(see page 94)*, you need to add the DTM for that module to the **DTM Browser**. After a module DTM has been added to the **DTM Browser**, you can use Unity Pro to:

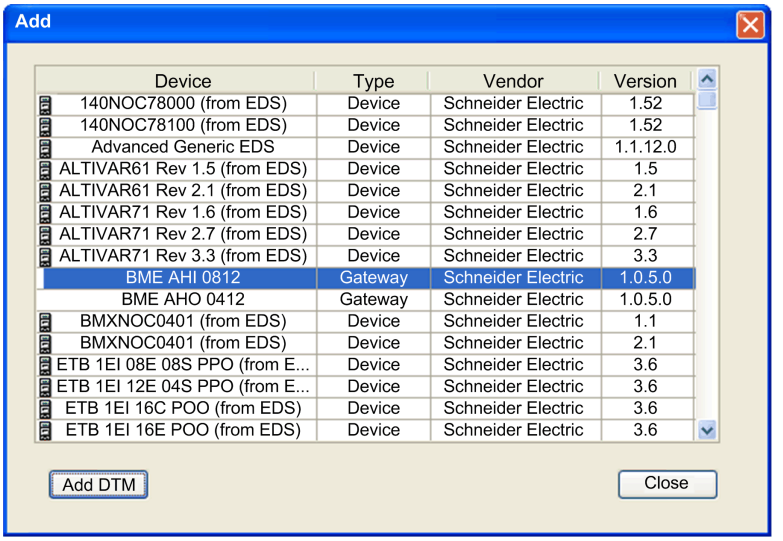
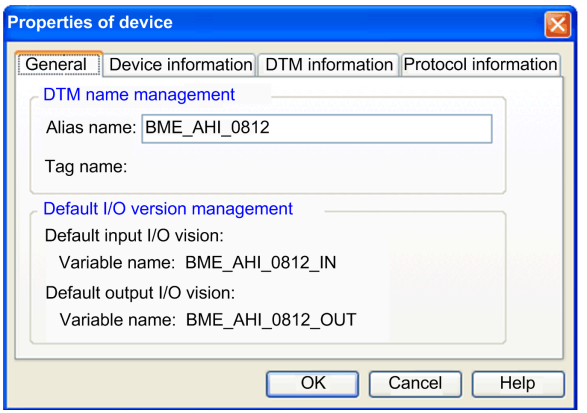
- configure DTM properties
- monitor dynamic DTM properties during run-time

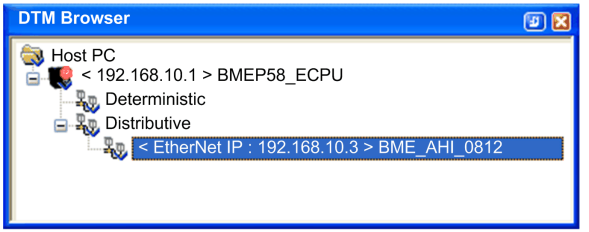
Adding a New DTM to the DTM Browser

To add a new DTM to the **DTM Browser**, follow these steps:

Step	Action
1	In the Unity Pro main menu, select **Tools** → **DTM Browser**. The **DTM Browser** opens displaying the CPU you selected for the project.

Step	Action
2	Select the CPU, and click the right mouse button. A context menu opens: 

Step	Action
3	Select **Add**. The **Add** dialog opens: 
4	Select an input or output module that you previously added to the **PLC Bus**, and then click **Add DTM**. The **Properties of device** dialog opens: 

Step	Action
5	Accept the **Alias name** proposed by Unity Pro or type in a different name; then click **OK**. Unity Pro adds a new module to the **DTM Browser**: 

Section 9.2
Configuring the Module IP Address

Overview

This section shows you how to configure module IP address settings.

What Is in This Section?

This section contains the following topics:

Topic	Page
Assigning IP Addressing Parameters	111
Configuring IP Address Settings	112

Assigning IP Addressing Parameters

IP Addressing Parameters

When a new BME AHI 0812 or BME AHO 0412 module is shipped from the factory, it does not come with pre-configured IP address settings. IP address settings include:

- IP address
- subnet mask
- default gateway

You need to configure the module to receive IP address settings from a DHCP server.

First Power-Up

When you first connect the module to an Ethernet network and power it up, it transmits a request for IP address settings. The request can be handled by a DHCP server.

If both of the following conditions exist, the server assigns the module its IP address settings:

- DHCP server exists on the network.
- The server is configured to recognize the module by its device name.

NOTE: Consult with your system administrator to determine if a DHCP server exists on your network. Your system administrator can help you configure the server to maintain the module IP address settings.

Configuring IP Address Settings

Master DTM

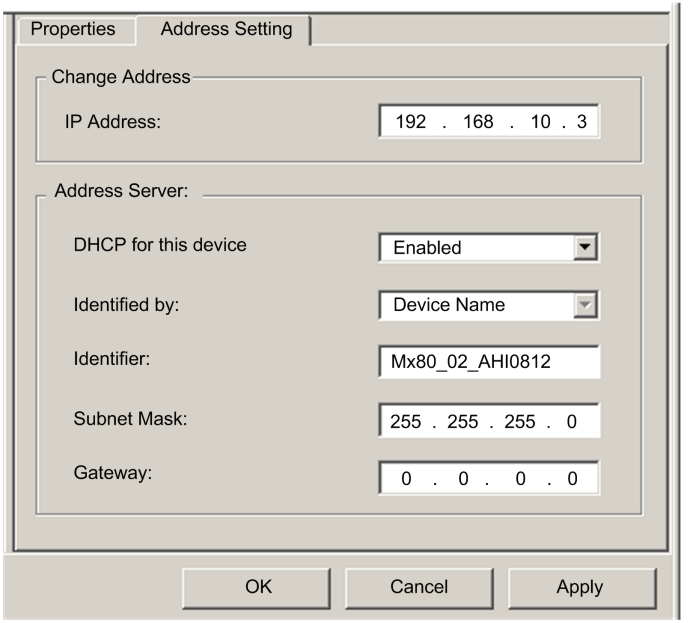
Use the master DTM to configure the IP address settings the master DTM will use when communicating with the HART module.

Because the HART module is designed to receive its IP address settings from the FDR server in the CPU, you need to configure the DHCP **Address Server** settings in the master DTM.

Accessing Module IP Address Properties

Follow these steps to access the **Address Settings** page for the HART analog I/O module, where you can input IP address settings:

Step	Action
1	In the **DTM Browser**, select the M580 CPU and click the right mouse button.
2	Select **Open** from the context menu. The master DTM configuration window opens.
3	Use the tree control on the left side of the DTM configuration window to navigate to a HART analog I/O module that you previously added to the configuration *(see page 106)*:

Step	Action	
4	Select the **Address Setting** tab to access the IP address configuration settings: 	
5	Use the following fields to configure IP address settings for the selected HART analog I/O module:	
	IP Address	Enter the IP address the FDR server in the CPU will serve to the selected HART analog I/O module.
	DHCP for this device	Select **Enabled**.
	Identified by	Select **Device Name**.
	Identifier	Enter the **Device Name** identifier for the selected HART analog I/O module. **NOTE:** Refer to the topic Creating a Device Name for DHCP (*see page 114*), below.
	Subnet Mask:	Accept the default value.
	Gateway:	Accept the default value.
6	Click **Apply**.	
7	In the CPU master DTM, select **Channel Properties** in the navigation tree.	
8	Confirm that the **Source IP Address** is correct. **NOTE:** Unity Pro uses this IP address to communicate with the CPU.	

Creating a Device Name for DHCP

When the DHCP client service is enabled in the master DTM, the HART analog I/O module uses the **Device Name** identifier to request an IP address from the FDR server in the CPU. You need to create the **Device Name** identifier by concatenating the Rack ID and Slot Number values to the Module Name, as follows:

Device Name = **Rack ID_Slot Number_Module Name**

NOTE: When inputting Rack ID and Slot Number values, confirm that the values you input describe the actual module position in the rack.

The components of the concatenated **Device Name** include the following:

Parameter	Description

Rack ID	A 4-character field that identifies the rack used for the module:
	● Mx80: a main local rack
	● M58A: primary rack in a Hot Standby network design
	● M58B: standby rack in a Hot Standby network design
	● Cxxx: remote I/O rack, where:
	  ● C indicates CRA
	  ● xxx represents the rack number, an integer from 000...159

Slot Number	A field that identifies the position of the module in the rack.
Device Name	Use the following module names for the purpose of generating a **Device Name**: ● the string “AHI0812” (not including quotation marks) for the BME AHI 0812 module ● the string “AHO0412” (not including quotation marks) for the BME AHO 0412 module

Sample device name identifiers could be:

- Mx80_02_AHI0812 for a BME AHI 0812 module located at slot 2 of a main rack.
- M58A_03_AHI0812 for a BME AHI 0812 module located at slot 3 of a primary Hot Standby rack
- M58B_04_AHO0412 for a BME AHO 0412 module located at slot 4 of a standby Hot Standby rack
- C001_05_AHO0412 for a BME AHO 0412 module located at rack 1, slot 5 of a remote I/O rack

Section 9.3
Configuring the Module DTM

Overview

This section describes how to access the module DTM, and configure DTM properties.

What Is in This Section?

This section contains the following topics:

Topic	Page
FDT/DTM Configuration	116
Module Overview	117
Address Table	118
General Information	119
Host Communication Status	122
Instrument Status	123
Multiplexer Status	125
Process Data	127
SNMP Configuration	133
Parameter Configuration	135
Security	137
EIP Configuration	139

FDT/DTM Configuration

Navigating the DTM

Use Unity Pro as a Field Device Tool (FDT) to configure Device Type Manager files (DTMs). A DTM defines the device-specific configuration software of each BME AHI 0812 HART analog input module, and BME AHO 0412 HART analog output module.

NOTE: You can use a third-party FDT to configure the module DTM including, for example, *FieldCare Asset Management Software* by Endress+Hauser or *PACTware* a free download from the PACTware Consortium. If you elect to use a third-party FDT, not all of the device configuration dialogs will be accessible.

To open a DTM for configuration, right-click a device DTM in the **DTM Browser** and select **Open** from the context menu. The **fdtConfiguration** window opens for the selected DTM.

Use the tree control on the left of the window to navigate the following device configuration dialogs:

- Module Overview
- Address Table
- General Information
- Host Communication Status
- Instrument Status
- Multiplexer Status
- Process Data
- Configuration:
  - SNMP Configuration
  - Parameter Configuration
  - Security
  - EIP Configuration

The following topics explain how to use these DTM configuration screens.

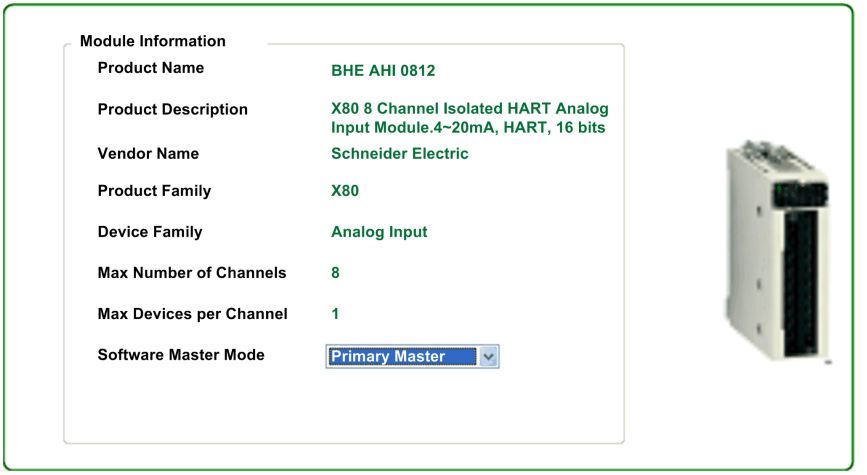
Module Overview

Module Information

Use the **Module Overview** dialog to:

- view static, self-explanatory module information, and
- view and edit the **Software Master Mode** setting for the gateway DTM

The **Module Overview** dialog for the BME AHI 0812:



Primary vs. Secondary Master

Two HART master devices can operate simultaneously: 1 primary master and 1 secondary master. Use the **Software Master Mode** setting to specify the relationship between the gateway DTM and the HART analog I/O multiplexer resident in the module, either:

- **Primary Master**: Select this if the gateway DTM is the primary master of the HART multiplexer.
- **Secondary Master**: Select this if this DTM is configured as the secondary master of the HART multiplexer.

  NOTE: When the module is configured as a secondary master:

- the **Configuration** parameters in the **General Information** dialog are read-only
- the **Address Table**, **Host Communication Status**, **Instrument Status**, and **Multiplexer Status** dialogs are not available

Address Table

Viewing DTMs for Field Instruments

Use the **Address Table** dialog to view a list of HART field instruments that have been added in the **DTM Browser**. Each channel links to only 1 instrument.

The **Address Table** includes the following properties for each detected field instrument:

Property	Type	Description
Channel	Read/Write	The channel number to which the field instrument is linked.
Matched State	Read-only	Indicates the identity of the field instrument detected on the channel: ● Equal: indicates the device ID and the vendor ID in the project configuration match the values in the field device. ● Not Equal: indicates the device ID and/or the vendor ID in the project configuration do not match the values in the field device.
Device Name	Read/Write	The name of the field instrument. The initial name is provided by the field instrument DTM.
Version	Read-only	The version of the field instrument, provided by the field instrument DTM.
Vendor	Read-only	The vendor of the field instrument, provided by the field instrument DTM.
Date	Read-only	The date of the field instrument DTM.
Description	Read-only	The description of the field instrument, provided by the field instrument DTM.

The **Address Table** dialog display refreshes at the rate of 1 channel per second. When a DTM for a new HART field device is added, the **Address Table** dialog automatically assigns the new instrument a channel number. Use the **Select channel** dialog to change the channel assignment so that it indicates the channel to which the instrument is connected.

Use the **Rescan** button to perform a scan of each connected field instrument DTM, and update the **Matched State** field for each channel.

General Information

Overview

Use the **General Information** dialog to:

- input static descriptive module information in the **Configuration** area
- input module addressing information in the **Rack and Slot Information** area
- view static settings – in the **Diagnostics** area – that describe the module, including:
  - the number of command preambles
  - unique module ID number
  - hardware, software, and command versions supported by the module
  - a description of the module and its manufacturer

NOTE: A DHCP server can assign an IP address to the module only if the DHCP service is enabled for the module, and a device name identifier is created, in the master DTM *(see page 112)*.

NOTE: In the master DTM, use the **Address Setting** tab for the specified module to enable the DHCP service. Then specify that a device name (and not MAC address) will be used, and enter the value for the device name identifier.

Parameters

The **General Information** dialog presents the following parameters:

The **Configuration area** includes the following parameters. Each parameter (except for **Device Name** is read/write. Parameters have the following initial factory default values:

Parameter	Description
Tag	A short (up to 8-character) text field that identifies the module. Default values are: ● for the BME AHI 0812: AHI0812 ● for the BME AHO 0412: AHO0412
Long Tag	A longer (up to 32-character) text field that identifies the module. Default values are: ● for the BME AHI 0812: HART ANALOG INPUT BMEAHI0812 ● for the BME AHO 0412: HART ANALOG OUTPUT BMEAHO0412
Description	A text field (up to 32-characters) that describes the module. Default values are: ● for the BME AHI 0812: HART AI AHI0812 ● for the BME AHO 0412: HART AO AHO0412
Message	A text field (up to 32-characters) that contains a module-related message. Default values are: ● for the BME AHI 0812: HART ANALOG INPUT BMEAHI0812 ● for the BME AHO 0412: HART ANALOG OUTPUT BMEAHO0412

Parameter	Description

Polling Address	An integer from 0...63 representing the HART client address for the module. A HART master device uses this address when making its first communication with the module.
	NOTE: For subsequent communications, the HART master uses a Long Address, which is a hexadecimal concatenation of:
	● the module *Device Type*, which is:
	  ● 0xE287 for the BME AHI 0812 module
	  ● 0xE288 for the BME AHO 0412 module
	● the module *Unique ID*, described below as a **Diagnostic** parameter.

The **Rack and Slot Information area** includes the following configurable (read/write) parameters:

Parameter	
Rack ID	A 4-character field that identifies the rack used for the module. Values include: ● Mx80: a main local rack ● M58A: a primary rack in a Hot-Standby network design ● M58B: a standby rack in a Hot-Standby network design ● Cxxx: a CRA remote I/O rack, where xxx represents the rack number – an integer from 000...159 **NOTE:** For a CRA rack, use the spin control (to the right of the rack selection list) to identify the remote I/O drop number.
Slot Number	The position of the module in the rack.

Device Name (read-only)	This read-only value is input in the master DTM *(see page 112)*, and is a concatenation of the following 3 values, separated by an underscore (_):
	● Rack ID
	● Slot Number
	● Module name, where:
	  ● AHI0812 represents the BME AHI 0812 HART analog input module
	  ● AHO0412 represents the BME AHO 0412 HART analog output module

Diagnostics area parameters include:

Parameter	Description
Manufactory Name	The name of the manufacturer.
Number of command preambles	The length of the preamble used by the module for HART messaging: a value from 5...20 bytes.
Manufactory device types	A string ID for the module: ● for the BME AHI 0812: BMEAHI0812 ● for the BME AHO 0412: BMEAHO0412
Universal command revision	The highest revision number of HART universal commands supported by the module
Software Version	The software version number of the module
Hardware Version	The hardware version number of the module

Parameter	Description
Flag	The module protocol type. For both the BME AHI 0812 and BME AHO 0412 the value is: ● 4 - Protocol Bridge Device
Unique ID Number	A unique hexadecimal identifier equal to the last 3 bytes of the module MAC address.

Host Communication Status

Monitoring Host Communications

Use the **Host Communication Status** dialog when operating online to view counts of HART communication transmissions between the HART multiplexer in the BME AHI 0812 or BME AHO 0412 and a host.

In the **Host Communication Status** dialog the:

- **Host Asking** area describes HART transmissions between the module and the gateway (or master) DTM, including:
  - **Number of commands** from the gateway DTM to the module, and
  - **Number of responses** from the module to the gateway DTM
- **Other Host** area describes HART transmissions between the module and any other HART master – such as asset management software or Unity Pro software– including:
  - **Number of commands** from the HART master to the module, and
  - **Number of responses** from the module to the HART master

Use the **Reset** button to reset to 0 the counting parameter values.

Instrument Status

Diagnosing HART Field Instrument Operations

Use the **Instrument Status** dialog while operating online to monitor the operation of HART field instruments connected to channels of the HART analog I/O module.

This dialog lists connected HART field instruments, and displays variable values for field instruments that are included in the scan. Scans are performed, and the dialog display refreshed, on 1 second intervals.

Place a check mark in the **Scan** column to include that instrument in the scan. Remove the check mark from the **Scan** column to remove that instrument from the scan.

Parameters

The **Instrument Status** dialog includes an upper table that lists the HART field instruments connected to a module channel, and a lower table that displays variable values for each scanned instrument. The parameters displayed vary depending on the **Scan Command** value selected in the **Multiplexer Status** page.

The channel-related parameters can include:

Parameter	Description
Channel	The channel number of the HART analog I/O module.
Manufacturer	The manufacturer of the HART field instrument.
Device Type ID	A hexadecimal value indicating the HART field instrument type.
Unique ID	The serial number of the HART field instrument.
Communication Status	The status of the HART field instrument communications, which can be: ● Buffer overflow – the message size exceeded the receive buffer of the instrument. ● Longitudinal parity mismatch – the longitudinal parity calculated by the instrument does not match the Check Byte at the end of the message. ● Framing error detected – The Stop Bit of one or more bytes received by the instrument was not detected by the UART (for example, a mark or a 1 was detected when a stop bit was expected). ● Overrun error detected – at lease 1 byte of date in the receive buffer was overwritten before it was read. ● Vertical parity error detected – the parity of one or more of the bytes received by the instrument was odd. ● Multi-Error detected with code displayed.

Parameter	Description
Device Status	The status of the HART field instrument: ● Primary variable out of limits – the primary variable is beyond its operating limit. ● Non-primary variable out of limits – an instrument variable not mapped to the PV is beyond its operating limit. ● Loop current saturated – loop current has reached its upper (or lower) endpoint limit and cannot increase (or decrease) any further. ● Loop current fixed – the loop current is being held at a fixed value and is not responding to process variations. ● More status available – additional status information is available via command 48 (read additional status information). ● Cold start – a power interruption or reset has occurred. ● Configuration changed – an operation was performed that changed the instrument configuration. ● Instrument not operational
Tries	The number of times the multiplexer attempted to connect to the field instrument.
Failures	The number of times the multiplexer did not receive a response from the field instrument.
Scan	Select this to display dynamic values in the table below.

The variable-related parameters can include:

Parameter	Description
PV[1]	The primary variable value.
SV[1]	The secondary variable value.
TV[1]	The tertiary variable value.
QV[1]	The quarternary variable value.
PV Loop Current	The primary variable loop current in mA.
PV Percent of Range	The primary variable value as a percent of the value range.
1. The content of each variable is instrument-specific, as determined by the manufacturer.	

Click **Reset** to set to 0 the counting statistics of the channel-related parameters, and to update the **Device Status** value of each connected HART field instrument.

Multiplexer Status

Multiplexer Scanning

Use the **Multiplexer Status** dialog to:

- perform the following offline configuration tasks:
  - enable and disable scanning by the multiplexer of HART field instruments
  - specify a **Scan Mode**
  - set maximum limits for both **Communication Count** and **Busy Retry Count**
- monitor statistical data describing the operation of the HART multiplexer
- diagnose the multiplexer status using status LEDs

HART Port Parameters

The following HART port parameters can be accessed in the **Multiplexer Status** dialog:

Parameter	Description
Scan Command	Specify a scan command: ● Read PV ● Read Current (mA) and % of Range ● Read Current (mA), PV, SV, TV and QV
Scanning	Specify a scan mode: ● ON: enable scan ● OFF: disable scan
Communication Retry Count	Type in the number of times the HART interface module resends a command to a non-responsive HART instrument. Valid values = 0...5. Default = 0.
Busy Retry Count	Type in the number of times the HART module resends a command after receiving a busy reply from a HART instrument. Valid values = 0...5. Default = 0.
Gender	The type of master: ● Primary (default) ● Secondary
Search Algorithm	Type of search performed for instruments on the loop: ● Poll Address 0 Only ● Poll Address 0 to 15 (default) ● Poll Address 0 to 63
Max Instruments Connected	The maximum number of instruments that can be connected to the multiplexer.
Instruments on Instrument List	The number of instruments on the instruments list.

Multiplexer Status

The **Multiplexer Status** dialog indicates the status of the multiplexer as a whole, and monitors the existence or absence of several multiplexer states. The status of each state is indicated by the LED color, as follows:

- Red indicates the existence of a detected event of the specified type.
- Green indicates normal operations.
- Gray indicates the DTM is offline and is not communicating with the device.

The **Multiplexer Status** dialog displays the following multiplexer status states:

State	Description
Device Malfunction	A detected error rendered the instrument non-operational.
Configuration Changed	An operation occurred that changed the instrument configuration. **NOTE:** Click **Reset** to clear detected faults and update module status.
Cold Start	The instrument was reset, or power was cycled off then on.
More Status Available	Additional instrument information is available via HART command 48 (Read Additional Status Information).

Process Data

Mapping I/O Data to the HART Multiplexer Scan

Use the **Process Data** dialog to:

- add selected HART I/O data items to the multiplexer scan, and
- remove HART I/O data items from the scan

Place a check mark in the **I/O** column next to each item you want to include in the HART multiplexer scan. Remove a check mark to remove that item from the scan. To help select or de-select items, you can click:

- **Select All** to place a check mark next to all input and output items, or
- **Restore to Defaults** to select only those input and output items that the application selects by default.

NOTE: When you select an item in the **Process Data** dialog, you also add a corresponding *Device DDT* variable to the **Data Editor** in Unity Pro.

I/O Data Items

These input items can be included in the HART multiplexer scan:

Input Data Item	Data Type	Mapped by Default?	Is Default Mapping Editable?	Bytes
Module Status	Word	Yes	Yes	4
Channel Status: 0...(N-1)	DWord	Yes	No	8 (BME AHI 0812) 4 (BME AHO 0412)
Channel 0...(N-1) Input Data:				
Instrument Status	32 bit unsigned	No	Yes	4
Primary Variable	Float	Yes	Yes	4
Secondary Variable	Float	Yes	Yes	4
Tertiary Variable	Float	Yes	Yes	4
Quaternary Variable	Float	Yes	Yes	4
Current Value	Float	No	Yes	4
Percent Value	Float	No	Yes	4
Update Counter	32 bit unsigned	No	Yes	4

These output items can be included in the HART multiplexer scan:

Output Data Item[1]	Data Type	Mapped by Default?	Is Default Mapping Editable?	Bytes
CH-ResetChanged	Byte	Yes	No	–
CH-Enable	Byte	No	Yes	–

1. When an output data item in the **Process Data** dialog is:
- *Selected*: the item is added to the list of Device Derived Data Types (DDDT) in the **Parameter Configuration** dialog, where program logic dynamically controls the item value during run-time.
- *De-selected*: the item is removed from the DDDT list. Program logic does not control the item value during run-time. The user can assign a static value to the item which is applied at start-up.

Module Status

The **Module Status** word presents a snapshot of the overall health of the HART analog I/O module and its channels.

Bit Number	Name	Description
0	Global Status	= 1 if the HART multiplexer has detected one or more of the following conditions: ● one or more HART channels are disconnected (bit 1 (Disconnected) = 1) ● a HART channel is connected to a field device that is materially different from the device configured for that channel; for example, a device of different device type or made by a different manufacturer. (bit 3 (Instrument Changed, Major) = 1) ● an internal communication event—ICE—has occurred (bit 4 (ICE) = 1)
1	Disconnected	= 1 if any channel is in the disconnected (CH-Disconnected) state
2	Instrument Changed, Minor	=1 if any channel is in the instrument changed, minor (CH-MinorDiff *(see page 129)*) state
3	Instrument Changed, Major	=1 if any channel is in the instrument changed, major (CH-MajorDiff *(see page 129)*) state
4...6	—	= 0 (not used)
7	ICE	= 1 on the occurrence of an *internal communication event*
8...15	—	= 0 (not used)

Channel Status

The **Channel Status** words report the status of each of the module channels. **Channel Status** values are as follows:

Value	Name	Description
0	CH-Disabled	The channel is disabled.
1	CH-Connecting	The module is searching for, and attempting to connect with, a HART instrument on the channel.
2	CH-Connected	The channel is connected to a HART instrument.
3	CH-MinorDiff	One or more minor differences *(see page 132)* exist between the connected HART instrument and the instrument description in the multiplexer island configuration.
4	CH-MajorDiff	One or more major differences *(see page 131)* exist between the connected HART instrument and the instrument description in the multiplexer island configuration.
5	CH-Disconnected	This state indicates either: ● The module discovered no HART instrument on the channel after performing 2 scans of the specified address range. ● The module discovered a HART instrument on the channel, but the connection was lost. The module continues to search for a HART instrument on this channel.
6...31	—	(not used)

Channel 0...(N-1) HART Instrument Specific Data Items

The module can also receive from a HART instrument, and add to the multiplexer scan, the following data items for each HART channel:

- Primary Variable (PV): manufacturer defined
- Instrument Status: reports one of the following conditions:
  - Device malfunction: a detected error rendered the instrument non-operational
  - Configuration changed: an operation occurred that changed the instrument configuration
  - Cold start: the instrument was reset, or power was cycled off then on
  - More status available: additional instrument information is available via HART command 48 (Read Additional Status Information)
  - Loop current fixed: current on the HART channel is being held at a fixed value, and is not responding to process variations
  - Loop current saturated: current on the HART channel has reached its upper or lower limit, and cannot increase or decrease further

  - Non-primary variable out of limits: the value of an instrument variable, other than the Primary Variable (PV), has traveled beyond its operating limits
  - Primary variable out of limits: the value of the instrument Primary Variable (PV) has traveled beyond its operating limits
- Secondary Variable (SV): manufacturer defined
- Current Value: the actual reading of loop current, from 4...20 mA
- Percent Value: the actual reading of loop current, expressed as a percent of the 16 mA range
- Update Counter: a counter that is incremented on each scan

Check the documentation for your specific HART instrument to determine which of the above data items it offers.

CH-ResetChanged

Use the **CH-ResetChanged** data item to accept a HART instrument that the module has detected to be different from the instrument that previously was connected to the same channel. In this case, the channel has a **Module Status** value of either **Instrument Changed, Minor** or **Instrument Changed, Major**.

When a bit in this register transitions from 0 to 1, a HART instrument on that channel is accepted as the current instrument.

The **CH-ResetChanged** word includes the following bits:

Bit Number	Name	Description
0	CH-0 Reset	The 0 to 1 transition clears the changed instrument flag, and accepts the detected HART instrument as the identified instrument for that channel,
1	CH-1 Reset	
2	CH-2 Reset	
3	CH-3 Reset	
4	CH-4 Reset	
5	CH-5 Reset	
6	CH-6 Reset	
7	CH-7 Reset	
8...15	—	(not used)

NOTE: The number of available channels is determined by the specific module.

CH-Enable

The **CH-Enable** output item reports and controls the state—enabled or disabled—of each of the channels of the HART I/O module. Every channel is enabled by default.

The bits in the **CH-Enable** word:

Bit Number	Name	Description
0	CH-0 Enable	• 0 = disabled • 1 = enabled (default)
1	CH1 Enable	
2	CH-2 Enable	
3	CH-3 Enable	
4	CH-4 Enable	
5	CH-5 Enable	
6	CH-6 Enable	
7	CH-7 Enable	
4...15	—	Set to a value of 0.

NOTE: The number of available channels is determined by the specific module.

Major and Minor Differences

When the module establishes connection with a HART instrument, it checks whether the present connection is the first connection made on the channel.

If there was a previous connection, the module checks whether the connected instrument matches the previously connected instrument. It does this by comparing the instrument-defining elements in the presently connected instrument with those recorded for the previously connected instrument.

The module gathers data from the HART instrument in the same manner whether the instrument is connected, connected with major differences, or connected with minor differences.

NOTE:

- To see which instrument-defining element has changed, you can use HART command 0 (Read Unique Identifier) to examine the definition of the presently connected HART field device.
- To accept a connected HART field instrument that has either major differences or minor differences, set the value of the **CH-ResetChanged** parameter to 1 for the appropriate channel.

Major Differences

Differences in the following definitions of a HART field instrument are described as major:

- Expanded Device Type
- Device Revision Level: only if the major revision number is different
- Software Revision Level of this device: only if the major revision number is different
- Flags
- Manufacturer Identification Code
- Private Label Distributor Code
- Device Profile

Minor Differences

The following differences in the definition of a HART field instrument are described as minor:

- HART Protocol Major Revision Number implemented by this device: for HART revision 7, this is the number 7.
- Device Revision Level: only if the minor revision number is different
- Software Revision Level of this device: only if the minor revision number is different (most significant 5 bits)
- Hardware Revision Level of the electronics in this device: does not necessarily trace individual component changes.
- Device ID: this number needs to be different for every device manufactured with a given Device Type.

SNMP Configuration

SNMP Agent

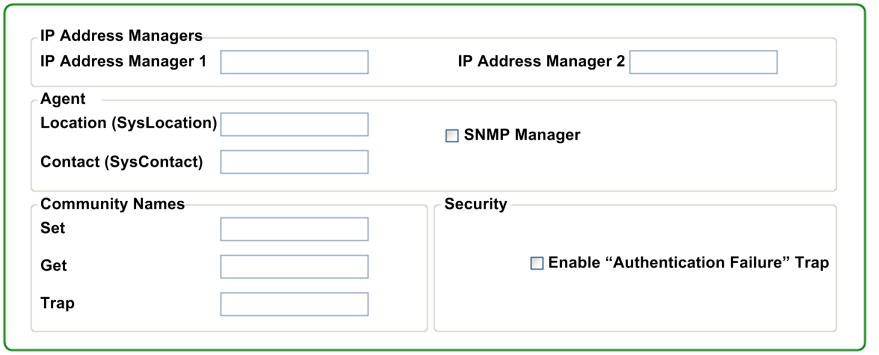
The module includes an SNMP v1 agent. An SNMP agent is a software component that allows access to the processor diagnostic and management information via the SNMP service.

SNMP browsers, network management software, and other tools typically use SNMP to access this data. In addition, the SNMP agent can be configured with the IP address of up to 2 devices–typically PCs running network management software–to be the target of event driven trap messages. These trap messages inform the management device of events such as cold start, and detected authentication failures.

Use the **SNMP** tab to configure the SNMP agent in the processor. The SNMP agent can connect to and communicate with up to 2 SNMP managers as part of an SNMP service. The SNMP service includes:

- authentication checking, by the processor, of any SNMP manager that sends SNMP requests
- management of event, or trap, reporting by the processor

The **SNMP Configuration** dialog:



Configuring SNMP Properties

The module includes the following SNMP properties:

Property	Description
IP address managers:	
IP address manager 1	The IP address of the first SNMP manager to which the SNMP agent sends notices of traps.
IP address manager 2	The IP address of the second SNMP manager to which the SNMP agent sends notices of traps.
Agent:	
Location	The device location (32 characters maximum)

Property	Description
Contact	Information describing the person to contact for device maintenance (32 characters maximum).
SNMP manager	When this checkbox is: ● selected: The location and contact information are not editable in this page. The module is able to restore the last location and contact set by SNMP manager. ● de-selected: Location and contact settings are editable in this page. Default = de-selected.
Community names:	
Get	Password required by the SNMP agent before executing read commands from an SNMP manager. 16 characters maximum. Default = **public**.
Set	Password required by the SNMP agent before executing write commands from an SNMP manager. 16 characters maximum. Default = **private**
Trap	Password an SNMP manager requires from the SNMP agent before the manager will accept trap notices from the agent. 16 characters maximum. Default = **alert** **NOTE:** ● Traps are sent via UDP port 161. ● You may need to configure trap settings on the SNMP manager, consistent with trap settings on the processor.
Security:	
Enable “Authentication Failure” trap	If an unauthorized manager sends a Get or Set command to the SNMP agent, the agent sends a trap notification message to the manager. Default = de-selected.

Parameter Configuration

Configuring Channel Properties

Use the **Parameter Configuration** dialog to configure the HART channels. In this dialog, you can:

- enable or disable each of the HART channels
- for each enabled channel specify:
  - the minimum number of preambles the module uses to communicate with a HART instrument
  - the value assigned to the primary variable if communication between the module and the HART instrument is disrupted

Create the module configuration settings offline, and then download them – along with the rest of the project configuration settings.

Configuring Parameters

You can configure the following parameters for the HART analog I/O module:

Parameter Name	Description
CH-Enable	The state of the HART channels. The **CH-Enable** value equals the sum of the binary values of every channel that is enabled. **NOTE:** The **CH-Enable** parameters can be enabled or disabled in this dialog only if **CH-Enable** is de-selected in the **Process Data** dialog.
• Channel 0...(N-1)	Sets the status of the selected channel to one of the following settings: • 0 = disabled • 1 = enabled (default)
Channel 0...(N-1) Settings	
• Number of Preambles	The minimum number of preambles the HART module uses to communicate with a HART instrument. If the HART instrument requires: • more preambles, the HART interface module sends more preambles • fewer preambles, the HART interface module sends the minimum number configured by this setting Default = 5.
• Fallback Mode Setting	If the HART instrument on this channel is disconnected, or if there is no HART instrument, this setting determines the value that is assigned to the primary variable (**PV**): • Set to 0 • Hold Last Value • Not a Number (NaN) Default = NaN

Restore Default Values

You can click the **Restore to Defaults** button to reset the modified values in this dialog to their default values.

Downloading Configuration Settings

To download an edited parameter configuration, follow these steps:

Step	Action
1	In the **DTM Browser**, right click on the HART gateway DTM.
2	In the context menu, select **Additional Functions** → **Transfer to FDR Server**.
3	When the transfer is complete, the message “Transfer to FDR Server is Successful” displays. Click **OK**.

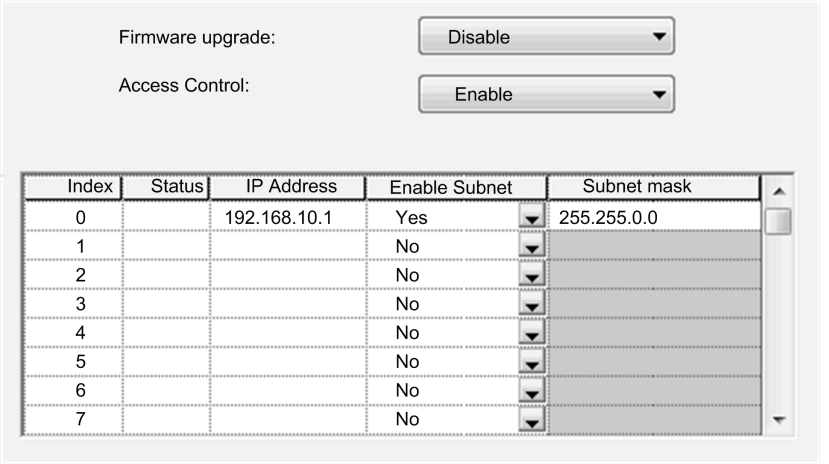
Security

Controlling Module Access

Use the **Security** page to restrict access to the module, as follows:

- Temporarily enable the module to receive firmware upgrades *(see page 71)* via FTP. When the firmware upgrade is complete, it is recommend that you disable the ability of the module to receive FTP transfers of firmware upgrades.
- Enable Ethernet access control; then restrict module access to up to 32 hosts per subnet on the Ethernet network. When access control is disabled, the module accepts Ethernet communications from any IP address.

The **Security** dialog:



IP Addresses to Be Added

When access control is enabled, add the following IP addresses to the list:

- Any network host that may send an Ethernet transmission to the module
- Your own maintenance PC so that you can communicate with the module via Unity Pro to configure and diagnose your application

NOTE: By default, the setting for index item 0 is the subnet of the HART multiplexer with subnet mask 255.255.0.0, which means the HART multiplexer can be accessed by a host in the same subnetwork.

Security Commands

You can set the following flags in the **Security** dialog:

Parameter	Description
Firmware Upgrade	Select either: ● Enable: Select this for a brief time to allow FTP access to the module for performing a firmware upgrade. ● Disable: When a firmware upgrade is not currently being performed by an authorized individual, select this to help protect the module against an unauthorized firmware upgrade.
Access Control	Select either: ● Enable: Select this to activate Ethernet access control. When access control is enabled, only hosts with IP addresses added to the list may access the module. ● Disable: When access control is disabled, any host may access the module via Ethernet.

Adding and Removing IP Addresses in the Authorized Access List

To add IP addresses to the **Authorized Access** list, follow these steps:

Step	Action
1	In the **Security** field, set **Access Control** to **Enabled**.
2	In the **Authorized Addresses** area, click in the **IP Address** field in the next empty row.
3	Enter the IP address you wish to add to the list.
4	If the IP address requires a subnet mask, do the following: In the **Enable Subnet** column, do one of the following: ● If the IP address requires a subnet mask, select **Yes**, then enter the subnet mask into the **Subnet Mask** field. ● If the IP address does not require a subnet mask, select **No**.
5	Repeat steps 2...4 for each IP address you want to add to the list.

To remove an IP address from the list, highlight the row and press the **Delete** key on your keyboard.

EIP Configuration

EtherNet/IP Implicit I/O Connections

Use the **EIP Configuration** dialogs to configure EtherNet/IP connections for the HART analog I/O module. You can configure the module for the following types of implicit I/O connections:

- None (no connection – if selected, the settings on this page become read-only)
- Exclusive Owner Connection
- Listen Only Connection

Configuring EIP Connections

The following parameters can be configured for an EtherNet/IP connection

Parameter	Description
RPI	The refresh period for this connection. This parameter should be set to a value from 20...1000 ms. Default = 20 ms.
Input T->O	
Input size	(read-only) The number of bytes reserved for input data. The number is calculated by the DTM, based on the settings entered in the **Process Data** page. The default value depends on the module: ● BME AHI 0812 = 140 bytes ● BME AHO 0412 = 72 bytes **NOTE:** Unity Pro reserves input data in increments of 2 bytes (1 word).
Input mode	The transmission type: ● Point to point: Transmission from adapter to scanner. ● Multicast: Transmission from a scanner to a multicast IP address (default). **NOTE:** An Exclusive Owner connection can be either point to point or multicast. A Listen Only connection is multicast.
Input type	Ethernet packet type – fixed or variable length – to be transmitted. Only fixed-length packets are supported.
Input priority	The transmission priority. Values can include: ● Scheduled (default) ● Low ● High
Input trigger	The transmission trigger. Values can include: ● Cyclic (default) ● Change of State
Output O->T **NOTE:** Output group parameters are configured only for Exclusive Owner connections. Listen Only connections do not send output.	

Parameter	Description
Output size	(read-only) The number of bytes reserved for output data. The number is calculated by the DTM, based on the settings entered in the **Process Data** page. The default value for both the BME AHI 0812 and the BME AHO 0412 is 1 byte. **NOTE:** Unity Pro reserves output data in increments of 2 bytes (1 word).
Output mode	The transmission type. For output transmissions over Exclusive Owner connections, only Point to point is supported.
Output type	Ethernet packet type – fixed or variable length – to be transmitted. Only fixed length packets are supported.
Output priority	The transmission priority. Values can include: ● Scheduled (default) ● Low ● High

Section 9.4
Completing the Project Configuration

Overview

This section describes how to add HART field device DTMs, enable HART channels, and generate the project configuration files.

What Is in This Section?

This section contains the following topics:

Topic	Page
Manually Adding a Field Instrument DTM	142
Field Bus Discovery Service	144
Transferring the Configuration to the CPU	147
Accessing Field Instrument Data in Unity Pro	149

Manually Adding a Field Instrument DTM

Overview

After you add a HART gateway DTM to the **DTM Browser**, you can then add a field instrument DTM.

NOTE: Before you can add a field instrument DTM, you need to confirm that the device DTM has been installed on your PC. If the desired field instrument DTM has not yet been installed, follow the manufacturer instructions for installation of the DTM.

NOTE: When you next open Unity Pro, a message is displayed indicating the DTM catalog is out of date. Click **Yes** to update the DTM catalog, and add the newly installed field instrument DTM to the list of available DTMs.

After a field instrument DTM has been added to the **DTM Browser**, you can use Unity Pro to:

- configure DTM properties
- monitor dynamic DTM properties during run-time

Adding a Field Instrument DTM to the DTM Browser

To add a field instrument DTM to the **DTM Browser**, follow these steps:

Step	Action
1	If it is not already open, open the **DTM Browser** by selecting **Tools** → **DTM Browser** in the Unity Pro main menu.
2	In the **DTM Browser**, navigate to and select a HART gateway DTM–for example, the DTM for the BME AHI 0812–then click the right mouse button. A context menu opens.
3	Select **Add**. The **Add** dialog opens. **NOTE:** If the DTM for the field instrument you want to add to the project has been installed, it appears in the **Add** dialog. If the DTM does not appear in the list, you need to install the DTM for the desired field instrument.
4	In the **Add** dialog, select the DTM for the field instrument you want to add (for example, the KROHNE TT51 field instrument) to the project, then click **Add DTM**. The **Field bus discovery** dialog opens.
5	In the **Field bus discovery** dialog, select the **Channel** setting for the newly added HART field instrument, then click **OK**. The **Properties of device** dialog opens.
6	In the **Properties of device** dialog, either accept the default **Alias name** or enter a new one; then click **OK**. The selected DTM appears in the **DTM Browser** beneath the previously selected HART gateway DTM.
7	In the **DTM Browser**, select the HART gateway DTM that is connected to the field instrument DTM that was added above; click the right mouse button; then select **Open** from the context menu. The **fdtConfiguration** window opens for the selected HART gateway DTM.
8	In the navigation control on the left side of the **fdtConfiguration** window, navigate to and select **Address Table** to display a list of field instruments that are connected to the HART gateway module.

Step	Action
9	In the navigation control on the left side of the **fdtConfiguration** window, navigate to and select **Configuration** → **Parameter Configuration** to display a list of configurable parameters.
10	Expand the **CH-Enable** parameter; select **Enable** for the channel to which the new field instrument is connected; then click **Apply**. **NOTE:** If you cannot edit the **CH-Enable** channel settings, it is because this parameter is selected in the **Process Data** page and channels are dynamically enabled or disabled by operation of program logic. To enable a channel in the **Parameter Configuration** page, open the **Process Data** page, de-select the **CH-Enable** output parameter, then click **Apply**.

Field Bus Discovery Service

Overview

The field bus discovery service is available for BME AHI 0812 and BME AHO 0412 gateway DTMs that are connected to field devices. Only the first level devices below the gateway DTMs are detected – recursive scanning is not supported.

NOTE: A device that is connected on the field bus can be detected if:

- Its DTM is installed on the PC.
- The DTM hardware catalog is up-to-date with the DTM installed.

Field Bus Discovery Use

The results of the scanning process are compared to the registered DTMs in the DTM catalog of the host PC. If a match is found in the DTM catalog for a scanned device, the results include a **Match** property that describes the precision of the match.

The **Match** property displays one the following values:

- Exact:
  All identification attributes are matching. The correct device type was found.
- Generic:
  At least the Manufacturer ID and Device Type ID attributes match. The support level of DTM is “Generic Support”.
- Uncertain:
  At least the Manufacturer ID and Device Type ID attributes match. The support level of DTM is **not** “Generic Support”.

The following procedure explains how to use the Field Bus Discovery service:

Step	Action
1	In the **DTM Browser**, select either BME AHI 0812 or a BME AHO 0412 gateway DTM.
2	If the gateway DTM is not connected to its field devices, right-click to open the contextual menu and select **Connect**.
3	With the gateway DTM selected, right-click to open the contextual menu and select **Field bus discovery**. The **Field bus discovery** channel selection dialog opens.
4	In the **Field bus discovery** channel selection dialog, select a channel for discovery and click **OK**. The service and performs discovery for the selected channel.
5	If at least one matched device has been found, the Field Bus Discovery dialog *(see page 145)* opens listing the scanned and matched devices.
6	Use the 3 buttons (Add one, Add all, Remove), described below to select and add matched devices that are added to the **DTM Browser**.
7	Click **OK** to insert the selected device DTMs into the **DTM Browser**. The **On Line Modification Authorization** message box opens, informing you that you need to rebuild the project offline. Click **Yes** to continue.

Step	Action
8	If there are one or more devices in the **Selected DTMs** list with the same address as a device that is already included in the **DTM Browser**, a message box opens asking if you want to continue. If you click **OK**, each pre-existing device with an address that is the same as a selected device is deleted and replaced by the DTM selected in the **Selected DTMs** list.
9	After the project is rebuilt, the discovered and selected field devices appear in the **DTM Browser** beneath the selected gateway DTM.

Field Bus Discovery Dialog

If at least one matched device has been discovered, the **Field bus discovery** dialog is displayed listing the scanned and matched devices. Select the matched devices to be added to the **DTM Browser**. The device you select appear in the **Selected DTMs** list. This dialog has three lists:

List	Description
Scanned Devices	Displays all the devices (matched and unmatched) found during the scan.
Matched DTMs	Displays the matched DTM found in the workstation DTM catalog for the selected device in the **Scanned Devices** list. Each time a scanned device is selected in the **Scanned Devices** list, the contents of the **Matched Devices** list is updated to display the matched device DTM found for the selected scanned device. The matching process can yield one or more matched devices for a given scanned device. In this case, select one among the matched DTMs found.
Selected DTMs	Displays the device DTMs selected to be added to the **DTM Browser**.

The lists present a colored icon for each item:

Color	Description
Green	The device has been selected
Yellow	The device has been matched
Red	The device has **not** been matched
Black	Information about the address of the scanned device: ● In the **Scanned Devices** list, the device has an address identical to one of the DTMs in the Unity Pro project. ● In the **Matched DTMs** list, the device is assigned an address identical to one of the DTMs in the Unity Pro project.

The **Matched DTMs** and **Selected DTMs** lists present these 3 buttons:

Button	Use this button to...
Add all	Automatically add the most closely matched device DTM for each discovered device in the **Matched DTMs** list to the **Selected DTMs** list.
Add one	Add the matched device DTM selected in the **Matched DTMs** list to the **Selected DTMs** list.
Remove	Remove one or more devices from the **Selected DTMs** list.

Transferring the Configuration to the CPU

Overview

After you have completed configuring the modules and field instruments that you have added to the project, the next task is to transfer the project to the FDR server in the CPU. The files you need to transfer depend on the specific edits you made to the project configuration

If you edited a HART Gateway module...	You need to...
Process Data page	Rebuild and transfer the Unity Pro project file to the CPU, then transfer the HART gateway module DTM configuration to the CPU.
EtherNet/IP Configuration page	
General Information page **Device Name** setting	Transfer the HART gateway module DTM configuration to the CPU.
SNMP Configuration page	
Parameter Configuration page	
Security page	

Rebuilding and Transferring the Unity Pro Project to the CPU

When you change settings in the **Process Data** page, the memory structure of the project is changed and you need to rebuild the project and transfer it to the CPU:

Step	Action
1	In the main menubar, select **Build** → **Rebuild All Project**. Unity Pro builds the project. When the rebuild is complete, the task bar displays the word “Built”.
2	In the main menubar, select **PLC** → **Set Address...**. The **Set Address** dialog opens.
3	In the PLC area of the **Set Address** dialog: ● Select the CPU IP address from the drop-down list. ● Select **TCPIP** as the Media. ● Click **Test Connection**. Unity Pro displays a message box if the connection is successful. Click **OK**.
4	In the main menubar, select **PLC** → **Connect**.
5	In the main menubar, select **PLC** → **Transfer Project to PLC**. The **Transfer Project to PLC** dialog opens.
6	Click **Transfer**. The project file is transferred to the CPU.

The transfer of the project file to the CPU does not include the transfer of the HART gateway module DTM configuration. To transfer the configuration file for the HART gateway module DTM, follow the steps described below.

Transferring the HART Gateway Module DTM to the CPU

To transfer the configuration settings of the HART gateway module DTM to the CPU, follow these steps:

Step	Action
1	Confirm that Unity Pro remains connected to the CPU. If not, select **PLC** → **Connect**.
2	In the **DTM Browser**, select the HART gateway module DTM (for example, the BME AHI 0812).
3	Click the right mouse button, then navigate through several sub-menus to select the following command: **Device menu** → **Additional functions** → **Transfer to FDR Server**. Unity Pro displays a message box indicating the transfer was successful.
4	Click **OK**.

Accessing Field Instrument Data in Unity Pro

Overview

This topic describes how to access the HART field instrument and its data.

Preliminary Tasks

Before you can access the HART field instrument and its data, you first need to complete the following preliminary tasks:

- create a project *(see page 93)* in Unity Pro
- add a HART gateway module *(see page 94)* (BME AHI 0812 or BME AHO 0412) to the project
- add a HART gateway module DTM *(see page 106)* to the project
- assign an IP address *(see page 112)* to the HART gateway module
- enable FTP and TFTP for the CPU and **Validate** the project (see referenced steps 7, 8 and 9)
- configure the HART gateway module DTM *(see page 116)*
- add the HART field instrument DTM *(see page 142)* to the project
- build the project file, connect to the CPU, then transfer the project *(see page 147)* to the CPU
- transfer the HART gateway module configuration *(see page 148)* to the CPU

Using an Animation Table to Connect to the HART Device

If the following output variables are selected in the **Process Data** page of the HART gateway module DTM, you may need to use an animation table to manually edit their settings:

- **G_Enable_ID**: if the channel for a HART field instrument is not enabled, you need to enable that channel.
- **G_ResetChanged_ID**: if the HART field instrument detected on the HART channel is different from the instrument previously specified for that channel, you need to accept the instrument actually detected on the channel.

To manually enable a channel for a HART field instrument, and accept the instrument detected on that channel, follow these steps:

Step	Action
1	In the **Project Browser**, navigate to **Project** → **Animation Tables** and click the right mouse button.
2	Select **New Animation Table**. A dialog of the same name opens.
3	In the **New Animation Table** dialog, accept the default **Name** or type in a new name, then click **OK**. The new animation table opens.
4	In the new animation table, double-click in the first cell of the first row. An ellipsis (...) appears.
5	Click on the ellipsis to open an **Instance Selection** dialog.
6	In the **Instance Selection** dialog, select the instance of the HART gateway module (for example a BME AHI 0812 module) and click **OK**. The selected object appears in the first row of the animation table.

Step	Action
7	In the animation table, expand the nodes for the module and outputs. **NOTE:** If CH-Enable and CH-ResetChanged are selected in the **Process Data** page, the **G_Enable_ID** and **G_ResetChanged_ID** objects are displayed.
8	Check the HART gateway module Analog and HART channel LEDs *(see page 31)* for the HART field instrument.
9	To enable every HART gateway module channel, for the object **G_Enable_ID**: ● click **Modification** in the animation table ● type **255** in the **Value** field ● click **Enter** The channels for the HART gateway module are enabled.
10	Again, check the HART gateway module Analog and HART channel LEDs *(see page 31)* for the HART field instrument. If the HART channel LED for the field instrument is flickering red, that field instrument is not recognized by the HART gateway module.
11	If you need to accept the field instruments detected by the HART gateway module on every channel, for the object **G_ResetChanged_ID**: ● click **Modification** in the animation table ● type **255** in the **Value** field ● click **Enter** The field instruments detected by the HART gateway module are accepted.

Accessing HART Field Instrument Data

Follow these steps to connect to a field instrument and access its data. This procedure uses the example of the KIROHNE TT51 HART field instrument.

Step	Action
1	In the **DTM Browser**, navigate to and right click on the HART field instrument, which is located beneath a HART gateway module. A context menu opens.
2	Select **Connect** to establish a connection between Unity Pro and the field instrument. **NOTE:** When a connection is established, the HART field instrument is displayed in **bold text**.
3	If necessary, select **PLC** → **Disconnect** to disconnect Unity Pro from the PLC.
4	In the **DTM Browser**, right click on the HART field instrument. A context menu opens.
5	Select **Load data from device** to load data from the HART field instrument into Unity Pro.
6	In the **DTM Browser**, right click on the HART field instrument. A context menu opens.
7	Select **Device menu** → **Observe** (in this example) to load data from the HART field instrument into Unity Pro.
8	Select the HART field instrument in the **DTM Browser**, then right click and select **Open** in the context menu. Basic HART data for the selected HART field instrument is now available from the DTM user interface.

Section 9.5
Working with Field Instrument Management Tools

Overview

This section describes how to access HART data from field instruments using a variety of field instrument management tools.

NOTE: Before you begin, the HART gateway module needs to be properly configured in Unity Pro, and the channel to each HART field instrument needs to be enabled.

What Is in This Section?

This section contains the following topics:

Topic	Page
Working with FieldCare	152
Working with PACTware	154

Working with FieldCare

Connecting FieldCare to a HART Field Instrument

NOTE: The following example describes third-party software. Refer to the manufacturer product documentation for detailed operating instructions.

Follow these steps to connect *FieldCare Asset Management Software* to a HART field instrument:

Step	Action
1	Follow the manufacturer instructions and install the FieldCare software. The installation needs to include the most recent FieldCare software patch, and each necessary DTM–including the DTM for the HART gateway module, and the HART field instrument.
2	Start the FieldCare software. If it displays a message indicating the DTM catalog is not up to date, click **Update**.
3	If the **Update DTM Catalog** dialog opens: ● Select each DTM that you need to add in the **Device Types not part of DTM Catalog** list (on the left). ● Click **Move>>**. The selected DTMs move to the **Device Types in DTM Catalog** list (on the right). ● Click **OK** to close the dialog.
4	When the FieldCare software starts, make the following selections: ● In the **1. Select the communication protocol:** list, select **EtherNetIP**. ● In the **2. Select the Communication DTM to be used:** list, select **EtherNet/IP Comm Adapter** by Schneider Electric. ● Click **Next**.
5	In the **Configuration** tab, for the **Host Address** select the IP address for the host PC running the FieldCare software. **NOTE:** The Host IP Address needs to be in the same subnet as the HART gateway module.
6	If FieldCare software displays a message indicating that it cannot scan the network for connected devices, click **OK** to close the message box.
7	In the **Network** window, right-click on the **Host PC** → **EtherNet/IP Comm Adapter** DTM; then select **Add Device...** from the context menu. The **Add New Device** window opens.
8	In the **Add New Device** window, select the HART gateway module DTM (for example, the BME AHI 0812 or the BME AHO 0412), then click **OK**.
9	In the **Network** window, double-click the **EtherNet/IP Comm Adapter** DTM to open it.
10	In the **AddressTable** tab, input the IP **Address** for the HART gateway DTM (for example, the BME AHI 0812 or the BME AHO 0412 you selected in step 8, then click **OK**. **NOTE:** Confirm the IP address you input is the address of the HART gateway module, and not the M580 CPU.
11	In the **Network** window, right-click on the HART gateway module DTM; then in the context menu select **Add Device...** The **Add New Device** dialog opens.
12	In the **Add New Device** window, select the DTM for the HART field instrument; then click **OK**.
13	In the **Assign Device to Channel** dialog, select the HART channel to which the field instrument is connected; then click **OK**.

Step	Action
14	In the **Network** window, right-click on the HART field instrument DTM; then in the context menu, select **Connect**. The HART field instrument is now ready to be accessed in the FieldCare software.
15	To view data from the HART field instrument, in the **Network** window right-click the HART field instrument DTM, then select **Observe** (for example) from the context menu. Data from the instrument is displayed and cyclically updated.

Working with PACTware

Connecting PACTware to a HART Field Instrument

NOTE: The following example describes third-party software. Refer to the manufacturer product documentation for detailed operating instructions.

Follow these steps to connect *PACTware* to a HART field instrument:

Step	Action
1	Follow the manufacturer instructions, and install the PACTware software. The installation needs to include each necessary DTM–including the HART gateway module DTM, and the HART field instrument DTM (for example, the TT51 device by KROHNE).
2	Run PACTware. If any updates are detected, follow the steps (if any) presented by PACTware to update the DTM library.
3	In the **Project** window, right-click on **HOST PC**; then select **Add device** from the context menu. The **Device for** dialog opens.
4	In the **Device for** dialog, select the **EtherNet/IP Comm Adapter** by Schneider Electric; then click **OK**.
5	In the **Project** window, right-click on **EtherNet/IP Comm Adapter**; then select **Add device** from the context menu. The **Device for** dialog opens.
6	In the **Device for** dialog, select the HART gateway module DTM (for example, the BME AHI 0812 or the BME AHO 0412); then click **OK**.
7	In the **Project** window, right-click on the HART gateway module DTM (for example, the BME AHI 0812 or the BME AHO 0412); then select **Add device** from the context menu. The **Device for** dialog opens.
8	In the **Device for** dialog, select the HART field instrument DTM (for example, the TT51 device by KROHNE); then click **OK**.
9	In the **Device for** dialog, double-click on the **EtherNet/IP Comm Adapter** to open its DTM.
10	In the **Configuration** tab, for the **Host Address** select the IP address for the host PC running the PACTware software. **NOTE:** The Host IP Address needs to be in the same subnet as the HART gateway module.
11	In the **AddressTable** tab, input the IP **Address** for the HART gateway DTM (for example, the BME AHI 0812 or the BME AHO 0412 you selected in step 8, then click **OK**. **NOTE:** Confirm the IP address you input is the address of the HART gateway module, and not the M580 CPU.
12	In the **Project** window, double-click on the HART gateway module to open its DTM.
13	In the **Address Table** page, input the HART channel to which the field instrument is connected; then click **OK**
14	In the **Project** window, right-click the HART field instrument DTM; then select **Connect** from the context menu.

Step	Action
15	In the **Project** window, right-click the HART field instrument DTM; then select **Load from device** from the context menu. The HART field instrument is now ready to be accessed in the PACTware software.
16	To view data from the HART field instrument, in the **Project** window right-click the HART field instrument DTM, then select **Measured value** from the context menu. Data from the instrument is displayed and cyclically updated.

Chapter 10
Analog Module Debugging

Overview

This chapter shows you how to use the debugging tools in Unity Pro.

NOTE: The **Debug** tab, described in the following topics, appears only for analog I/O modules placed in the main rack. This tab does not appear for analog I/O modules placed in remote drops.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Introducing the Debug Function of an Analog Module	158
Description of the Analog Module Debug Screen	159
Selecting the Adjustment Values for the Input Channels and Measurement Forcing	161
Modification of Output Channels Adjustment Values	163

Introducing the Debug Function of an Analog Module

Introduction

This function is accessible only in online mode, for analog modules placed in the main rack.

NOTE: The debug function is not available for analog I/O modules placed in remote drops.

For each input/output module of the project, it can be used to:

- display measurements
- display the parameters of each channel
- access the diagnostics and adjustment of the selected channel

The function also gives access to the module diagnostics in the case of an event.

Procedure

The procedure to access the debug function is as follows.

Step	Action
1	configure the module
2	transfer the application to the PLC
3	change to online mode
4	in the rack configuration screen, double-click the module
5	select the **Debug** tab

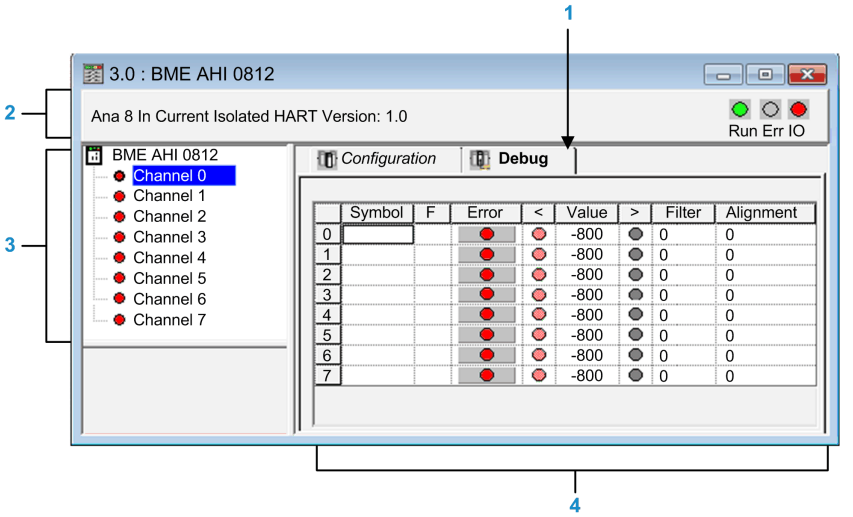
Description of the Analog Module Debug Screen

At a Glance

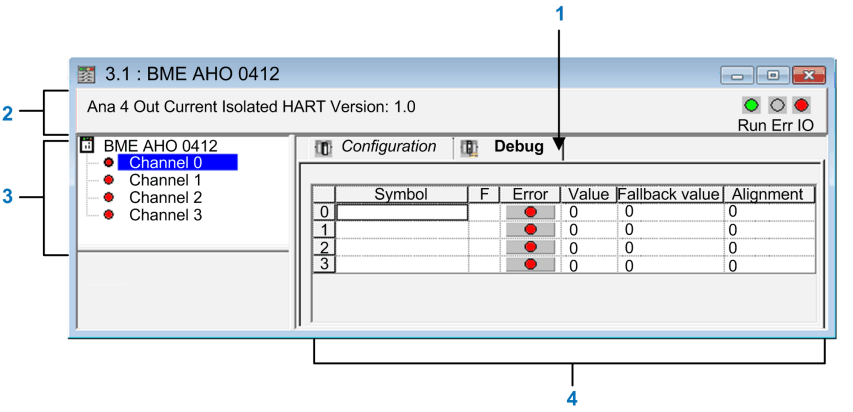
The **Debug** tab displays, in real time, the current value, and status for each module channel.

Debug Tabs

The input module **Debug** tab:



The output module **Debug** tab:



Parameters

The elements of the debug tab include:

Address	Element	Function
1	Tabs	The tab in the foreground indicates the mode in progress (**Debug** in this example). Each mode can be selected by the corresponding tab. The available modes are: ● **Debug** which can be accessed only in online mode. ● **Configuration**.
2	**Module** area	Specifies the shortened name of the module. In the same area there are 3 LEDs which indicate the status of the module in online mode: ● **RUN** indicates the operating status of the module, ● **ERR** indicates an internal detected error in the module, ● **I/O** indicates an event from outside the module or a detected application error.
3	**Channel** area	Is used: ● To select a channel. ● To display the **Symbol**, name of the user-defined channel (using the variable editor).
4	**Viewing and control** area	Displays the value and status for each channel in the module in real time. The symbol column displays the symbol associated with the channel when it has been defined this (from the variable editor). This area provides direct access to channel by channel diagnostics when these are inoperative (indicated by error column LED, which turns red). ● Access to the settings of the filtering, alignment and fallback values of the outputs, ● To channel-by-channel diagnostics when channels have a detected error (indicated by the LED built into the diagnostics access button, which turns red).

NOTE: LEDs and commands not available appear grayed out.

Selecting the Adjustment Values for the Input Channels and Measurement Forcing

At a Glance

Use this function to modify the filter, alignment and forcing value of one or more channels of an analog input module.

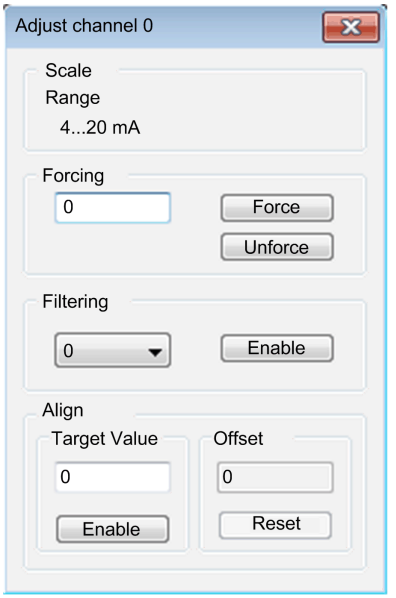
The available commands include:

- forcing
- filter
- alignment

To align several analog channels on the X80 input modules, we recommend proceeding channel by channel. Test each channel after alignment before moving to the next channel, in order to apply the parameters correctly.

Procedure

To modify the filter, forcing and alignment values, follow these steps:

Step	Action for a channel
1	Access the debug screen.
2	Select the channel to be modified in the **Display** zone and double-click in the corresponding box. **Result**: The **Adjust channel** dialog opens: 

Step	Action for a channel
3	Place the cursor in the **Forcing** field. Enter the forcing value. Send the forcing order by clicking the **Force** button.
4	Click the drop-down menu in the **Filtering** field, and define the new selected filter value. Confirm this selection by clicking **Enable**.
5	Place the cursor in the **Target Value** field, then input a target value. Confirm this selection by clicking **Enable**.
6	Close the **Adjust channel** dialog. **Results**: The new filter, forcing or alignment value appears in the box corresponding to the selected channel in the **Debug** tab.

Modification of Output Channels Adjustment Values

At a Glance

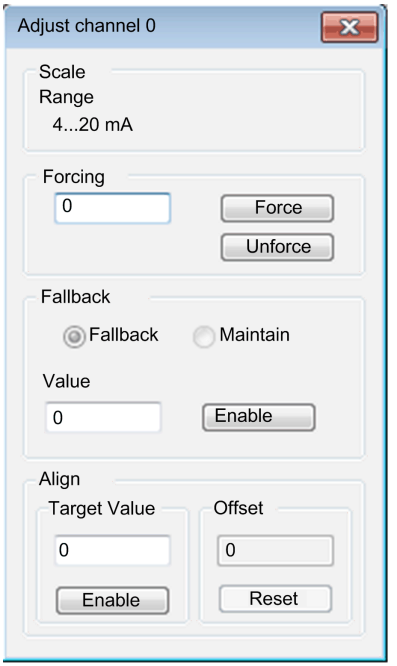
Use this function to modify the forcing, fallback, and alignment values for one or several output channels of an analog module.

The available commands include:

- forcing
- fallback
- alignment

Procedure

To modify the values to be applied at the output channels, follow these steps:

Step	Action for a Channel
1	Access the **Debug** tab.
2	Select the channel in the display zone and double-click in the corresponding box. **Result**: The **Adjust channel** dialog box appears. 
3	Place the cursor in the **Forcing** field. Enter the forcing value. Send the forcing order by clicking the **Force** button.

Step	Action for a Channel
4	Place the cursor in the **Value** field and enter the new fallback value. Confirm this new value by clicking **Enable**.
5	In the **Align** area, place the cursor in the **Target Value** field, and then input a target value. Confirm this selection by clicking **Enable**.
6	Close the dialog.

Chapter 11
Analog Module Diagnostics

Overview

This chapter shows you how to use the diagnostic tools in Unity Pro.

NOTE: The **Fault** tab, described in the following topics, appears only for analog I/O modules placed in the main rack. This tab does not appear for analog I/O modules placed in remote drops.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Diagnostics of an Analog Module	166
Detailed Diagnostics by Analog Channel	168

Diagnostics of an Analog Module

At a Glance

The module diagnostics function displays detected errors, classified according to category:

- **Internal detected error**:
  - module detected malfunction
  - self-testing detected error
- **External events**:
  - Wiring control (broken-wire)
  - Under range/over range
- **Other detected errors**:
  - configuration detected error
  - module missing or off
  - inoperative channel

A detected module error is indicated by a number of LEDs changing to red, such as:

- in the rack-level configuration editor:
  - the LED of the rack number
  - the LED of the slot number of the module on the rack
- in the module-level configuration editor:
  - the **Err** and **I/O** LEDs, depending on the type of detected error
  - the **Channel** LED in the **Channel** field

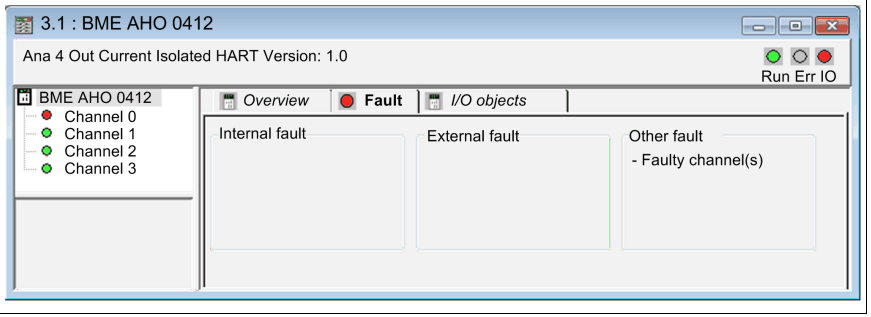
Procedure

The table below shows the procedure for accessing the module Fault screen.

Step	Action
1	Open the module debugging screen.
2	Click on the module reference in the channel zone and select the **Fault** tab. **NOTE:** It is not possible to access the module diagnostics screen if one of the following conditions is detected: ● a configuration error ● a major breakdown error ● a missing module The following message then appears on the screen: "`The module is missing or different from that configured for this position`."

Step	Action

Result: The list of module detected errors appears.



Detailed Diagnostics by Analog Channel

At a Glance

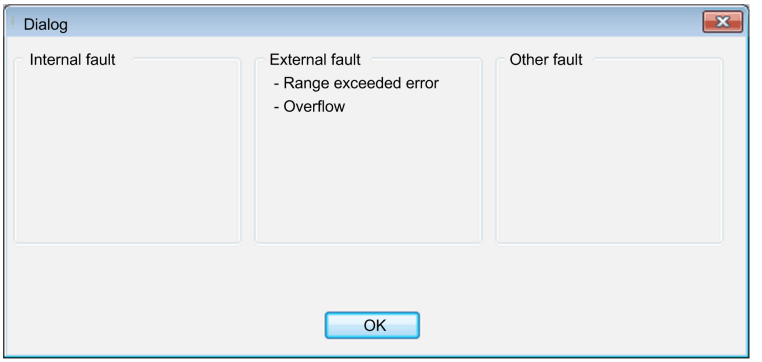
The channel diagnostics function displays detected errors when they occur, classified according to category:

- **Internal detected errors**
  - inoperative channel
  - calibration detected error
- **External events**
  - sensor link event
  - range overflow/underflow
- **Other detected errors**
  - configuration detected error
  - communication loss detected
  - application detected error
  - value outside range (output channel)
  - channel not ready

A channel detected error is indicated in the **Debug** tab when the LED, located in the **Error** column, turns red.

Procedure

To access the channel detected **Fault** dialog, follow these steps:

Step	Action
1	Open the module debugging screen.
2	For the inoperative channel, click the button situated in the **Error** column. **Result**: The list of channel detected errors appears.  **Note:** Channel diagnostics information can also be accessed by program (instruction READ_STS).

Chapter 12
IODDTs and Device DDTs

Overview

This chapter presents the various language objects, IODDTs, and device DDTs associated with analog input/output modules.

To avoid several simultaneous explicit exchanges for the same channel, test the value of the word EXCH_STS (`%MWr.m.c.0`) of the IODDT associated to the channel before calling any EF using this channel.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Detailed Description of T_ANA_IN_BMX-type IODDT Objects	170
Detailed Description of T_ANA_OUT_BMX-type IODDT Objects	173
Detailed Description of T_ANA_IN_GEN-type IODDT Objects	176
Detailed Description of T_ANA_OUT_GEN-type IODDT Objects	177
Details of the Language Objects of the IODDT of Type T_GEN_MOD	178
Analog Device DDT	179
Analog Device Ethernet Remote I/O Forcing Mode	186
Description of HART DDT Objects	188

Detailed Description of T_ANA_IN_BMX-type IODDT Objects

At a Glance

The following tables describe the T_ANA_IN_BMX-type IODDT objects applicable to **BME AHI 0812**, **BMX AMI 0410**, **BMX AMI 0800** and **BMX AMI 0810**, and to **the inputs of the BMX AMM 600 mixed module**.

Input Measurement

The analog input measurement object is as follows.

Standard symbol	Type	Access	Meaning	Address
VALUE	INT	R	Analog input measurement.	%IWr.m.c.0

%Ir.m.c.ERR error bit

The %Ir.m.c.ERR error bit is as follows.

Standard symbol	Type	Access	Meaning	Address
CH_ERROR	BOOL	R	Detected error bit for analog channel.	%Ir.m.c.ERR

MEASURE_STS Measurement Status Word

The meaning of the MEASURE_STS (%IWr.m.c.1) measurement status word bits is as follows.

Standard symbol	Type	Access	Meaning	Address
CH_ALIGNED	BOOL	R	Aligned channel.	%IWr.m.c.1.0
CH_FORCED	BOOL	R	Forced channel.	%IWr.m.c.1.1
LOWER_LIMIT	BOOL	R	Measurement within lower tolerance area.	%IWr.m.c.1.5
UPPER_LIMIT	BOOL	R	Measurement within upper tolerance area.	%IWr.m.c.1.6
INT_OFFSET_ERROR	BOOL	R	Internal offset detected error.	%IWr.m.c.1.8
INT_REF_ERROR	BOOL	R	Internal reference detected error.	%IWr.m.c.1.10
POWER_SUP_ERROR	BOOL	R	Power supply detected error.	%IWr.m.c.1.11
SPI_COM_ERROR	BOOL	R	SPI communication detected error.	%IWr.m.c.1.12

Explicit Exchange Execution Flag: EXCH_STS

The meaning of the exchange control bits of the channel EXCH_STS (%MWr.m.c.0) is as follows.

Standard symbol	Type	Access	Meaning	Address
STS_IN_PROGR	BOOL	R	Read channel status words in progress.	%MWr.m.c.0.0
CMD_IN_PROGR	BOOL	R	Command parameter exchange in progress.	%MWr.m.c.0.1
ADJ_IN_PROGR	BOOL	R	Adjustment parameter exchange in progress.	%MWr.m.c.0.2

Explicit Exchange Report: EXCH_RPT

The meaning of the EXCH_RPT (%MWr.m.c.1) report bits is as follows.

Standard symbol	Type	Access	Meaning	Address
STS_ERR	BOOL	R	Read error detected for channel status words.	%MWr.m.c.1.0
CMD_ERR	BOOL	R	Error detected during command parameter exchange.	%MWr.m.c.1.1
ADJ_ERR	BOOL	R	Error detected while exchanging adjustment parameters.	%MWr.m.c.1.2
RECONF_ERR	BOOL	R	Error detected while reconfiguring the channel.	%MWr.m.c.1.15

Standard Channel Status: CH_FLT

The following table explains the meaning of the CH_FLT (%MWr.m.c.2) status word bits. Reading is performed by a READ_STS (IODDT_VAR1).

Standard symbol	Type	Access	Meaning	Address
SENSOR_FLT	BOOL	R	Sensor connection detected error.	%MWr.m.c.2.0
RANGE_FLT	BOOL	R	Range under/overflow detected error.	%MWr.m.c.2.1
CH_ERR_RPT	BOOL	R	Channel detected error report.	%MWr.m.c.2.2
INTERNAL_FLT	BOOL	R	Inoperative channel.	%MWr.m.c.2.4
CONF_FLT	BOOL	R	Different hardware and software configurations.	%MWr.m.c.2.5
COM_FLT	BOOL	R	Problem detected communicating with the PLC.	%MWr.m.c.2.6
APPLI_FLT	BOOL	R	Application error detected (adjustment or configuration error).	%MWr.m.c.2.7
NOT_READY	BOOL	R	Channel not ready.	%MWr.m.c.3.0
CALIB_FLT	BOOL	R	Calibration detected error.	%MWr.m.c.3.2
INT_OFFS_FLT	BOOL	R	Internal calibration offset detected error.	%MWr.m.c.3.3
INT_REF_FLT	BOOL	R	Internal calibration reference detected error.	%MWr.m.c.3.4
INT_SPI_PS_FLT	BOOL	R	Internal serial link or power supply detected error.	%MWr.m.c.3.5
RANGE_UNF	BOOL	R	Recalibrated channel or range underflow.	%MWr.m.c.3.6
RANGE_OVF	BOOL	R	Aligned channel or range overflow.	%MWr.m.c.3.7

Command Controls

The following table explains the meaning of the COMMAND_ORDER (%MWr.m.c.4) status word bit. Reading is performed by a READ_STS;

Standard symbol	Type	Access	Meaning	Address
FORCING_UNFORCING_ORDER	BOOL	R/W	Forcing/unforcing command.	%MWr.m.c.4.13

Parameters

The table below presents the meaning of the %MWr.m.c.5, %MWr.m.c.8 and %MWr.m.c.9 words, as well as the threshold command words (%MWr.m.c.10 and %MWr.m.c.11). Queries used are those associated with parameters (READ_PARAM, WRITE_PARAM):

Standard symbol	Type	Access	Meaning	Address
CMD_FORCING_VALUE	INT	R/W	Forcing value to be applied.	%MWr.m.c.5
FILTER_COEFF	INT	R/W	Value of filter coefficient.	%MWr.m.c.8
ALIGNMENT_OFFSET	INT	R/W	Alignment offset value.	%MWr.m.c.9

NOTE: In order to force a channel, you have to use the WRITE_CMD (%MWr.m.c.5) instruction and set the %MWr.m.c.4.13 bit to 1.

NOTE: To unforce a channel and use it normally, you have to set the %MWr.m.c.4.13 bit to 0.

Detailed Description of T_ANA_OUT_BMX-type IODDT Objects

At a Glance

The following tables describe the T_ANA_OUT_BMX-type IODDT objects applicable to the **BME AHO 0412**, **BMX AMO 0210**, **BMX AMO 0410** and **BMX AMO 0802** analog output modules and the outputs of the **BMX AMM 600** mixed module.

Value of the Output

The analog output measurement object is as follows.

Standard symbol	Type	Access	Meaning	Address
VALUE	INT	R	Analog output measurement.	%QWr.m.c.0

%Ir.m.c.ERR error bit

The %Ir.m.c.ERR error bit is as follows.

Standard symbol	Type	Access	Meaning	Address
CH_ERROR	BOOL	R	Error bit for analog channel.	%Ir.m.c.ERR

Value Forcing

The value forcing bit is as follows.

Standard symbol	Type	Access	Meaning	Address
FORCING_VALUE	INT	R	Forcing of the value.	%IWr.m.c.0

Channel forcing indicator.

The meaning of the forcing control bits of the channel (%IWr.m.c.1) is as follows.

Standard symbol	Type	Access	Meaning	Address
CHANNEL_FORCED	BOOL	R	Forcing of the channel.	%MWr.m.c.1.1

Explicit Exchange Execution Flag: EXCH_STS

The meaning of the exchange control bits of the channel EXCH_STS (%MWr.m.c.0) is as follows:

Standard symbol	Type	Access	Meaning	Address
STS_IN_PROGR	BOOL	R	Read channel status words in progress.	%MWr.m.c.0.0

Standard symbol	Type	Access	Meaning	Address
CMD_IN_PROGR	BOOL	R	Command parameter exchange in progress.	%MWr.m.c.0.1
ADJ_IN_PROGR	BOOL	R	Adjustment parameter exchange in progress.	%MWr.m.c.0.2

Explicit Exchange Report: EXCH_RPT

The meaning of the EXCH_RPT (%MWr.m.c.1) report bits is as follows:

Standard symbol	Type	Access	Meaning	Address
STS_ERR	BOOL	R	Read error detected for channel status words.	%MWr.m.c.1.0
CMD_ERR	BOOL	R	Error detected during command parameter exchange.	%MWr.m.c.1.1
ADJ_ERR	BOOL	R	Error detected while exchanging adjustment parameters.	%MWr.m.c.1.2
RECONF_ERR	BOOL	R	Error detected while reconfiguring the channel.	%MWr.m.c.1.15

Standard Channel Status: CH_FLT

The following table explains the meaning of the CH_FLT (%MWr.m.c.2) status word bits. Reading is performed by a READ_STS (IODDT_VAR1).

Standard symbol	Type	Access	Meaning	Address
ACT_WIRE_FLT	BOOL	R	Actuator wire open or short.	%MWr.m.c.2.0
RANGE_FLT	BOOL	R	Range under/overflow detected error.	%MWr.m.c.2.1
SHORT_CIRCUIT	BOOL	R	Short-circuit.	%MWr.m.c.2.2
CAL_PRM_FLT	BOOL	R	Calibration parameters not configured.	%MWr.m.c.2.3
INTERNAL_FLT	BOOL	R	Inoperative channel.	%MWr.m.c.2.4
CONF_FLT	BOOL	R	Different hardware and software configurations.	%MWr.m.c.2.5
COM_FLT	BOOL	R	Problem detected communicating with the PLC.	%MWr.m.c.2.6
APPLI_FLT	BOOL	R	Application detected error (adjustment or configuration detected error).	%MWr.m.c.2.7
ALIGNED_CH	BOOL	R	Aligned channels.	%MWr.m.c.3.0
INT_CAL_FLT	BOOL	R	Calibration parameters not defined.	%MWr.m.c.3.2
INT_PS_FLT	BOOL	R	Internal power supply detected error.	%MWr.m.c.3.3
INT_SPI_FLT	BOOL	R	Serial link detected error.	%MWr.m.c.3.4
RANGE_UNF	BOOL	R	Range underflow.	%MWr.m.c.3.6
RANGE_OVF	BOOL	R	Range overflow.	%MWr.m.c.3.7

Command Control

The following table explains the meaning of the COMMAND_ORDER (%MWr.m.c.4) status word bit. Reading is performed by a READ_STS:

Standard symbol	Type	Access	Meaning	Address
FORCING_UNFORCING_ORDER	BOOL	R/W	Forcing/unforcing command.	%MWr.m.c.4.13

Parameters

The following table shows the meaning of the words %MWr.m.c.5 to %MWr.m.c.8. The requests used are those associated with the parameters (READ_PARAM and WRITE_PARAM).

Standard symbol	Type	Access	Meaning	Address
CMD_FORCING_VALUE	INT	R/W	Forcing value to be applied.	%MWr.m.c.5
FALLBACK	INT	R/W	Fallback value.	%MWr.m.c.7
ALIGNMENT	INT	R/W	Alignment value.	%MWr.m.c.8

NOTE: In order to force a channel, you have to use the WRITE_CMD (%MWr.m.c.5) instruction and set the %MWr.m.c.4.13 bit to 1.

NOTE: To unforce a channel and use it normally, you have to set the %MWr.m.c.4.13 bit to 0.

Detailed Description of T_ANA_IN_GEN-type IODDT Objects

At a Glance

The tables below present the T_ANA_IN_GEN-type IODDT objects that are applicable to the **BME AHI 0812**, **BMX AMI 0410**, **BMX AMI 0800** and **BMX AMI 0810** input modules, to the inputs of the **BMX AMM 600** mixed module and to the **BMX ART 0414/0814** analog input module.

Input Measurement

The analog input measurement object is as follows.

Standard symbol	Type	Access	Meaning	Address
VALUE	INT	R	Analog input measurement.	%IWr.m.c.0

%Ir.m.c.ERR Error Bit

The %Ir.m.c.ERR error bit is as follows:

Standard symbol	Type	Access	Meaning	Address
CH_ERROR	BOOL	R	Detected error bit for analog channel.	%Ir.m.c.ERR

Detailed Description of T_ANA_OUT_GEN-type IODDT Objects

At a Glance

The following tables describe the T_ANA_IN_GEN-type IODDT objects applicable to the **BME AHO 0412**, **BMX AMO 0210**, **BMX AMO 0410** and **BMX AMO 0802** analog output modules and to the output of the **BMX AMM 600** mixed module.

Input Measurement

The analog output measurement object is as follows.

Standard symbol	Type	Access	Meaning	Address
VALUE	INT	R	Analog output measurement.	%IWr.m.c.0

%Ir.m.c.ERR Error Bit

The %Ir.m.c.ERR error bit is as follows.

Standard symbol	Type	Access	Meaning	Address
CH_ERROR	BOOL	R	Detected error bit for analog channel.	%Ir.m.c.ERR

Details of the Language Objects of the IODDT of Type T_GEN_MOD

Introduction

The modules of Modicon M340 and X80 PLCs have an associated IODDT of type T_GEN_MOD.

Observations

In general, the meaning of the bits is given for bit status 1. In specific cases an explanation is given for each status of the bit.

Some bits are not used.

List of Objects

The table below presents the objects of the IODDT.

Standard Symbol	Type	Access	Meaning	Address
MOD_ERROR	BOOL	R	Module detected error bit	%Ir.m.MOD.ERR
EXCH_STS	INT	R	Module exchange control word	%MWr.m.MOD.0
STS_IN_PROGR	BOOL	R	Reading of status words of the module in progress	%MWr.m.MOD.0.0
EXCH_RPT	INT	R	Exchange report word	%MWr.m.MOD.1
STS_ERR	BOOL	R	Event when reading module status words	%MWr.m.MOD.1.0
MOD_FLT	INT	R	Internal detected errors word of the module	%MWr.m.MOD.2
MOD_FAIL	BOOL	R	module inoperable	%MWr.m.MOD.2.0
CH_FLT	BOOL	R	Inoperative channel(s)	%MWr.m.MOD.2.1
BLK	BOOL	R	Terminal block incorrectly wired	%MWr.m.MOD.2.2
CONF_FLT	BOOL	R	Hardware or software configuration anomaly	%MWr.m.MOD.2.5
NO_MOD	BOOL	R	Module missing or inoperative	%MWr.m.MOD.2.6
EXT_MOD_FLT	BOOL	R	Internal detected errors word of the module (Fipio extension only)	%MWr.m.MOD.2.7
MOD_FAIL_EXT	BOOL	R	Internal detected error, module unserviceable (Fipio extension only)	%MWr.m.MOD.2.8
CH_FLT_EXT	BOOL	R	Inoperative channel(s) (Fipio extension only)	%MWr.m.MOD.2.9
BLK_EXT	BOOL	R	Terminal block incorrectly wired (Fipio extension only)	%MWr.m.MOD.2.10
CONF_FLT_EXT	BOOL	R	Hardware or software configuration anomaly (Fipio extension only)	%MWr.m.MOD.2.13
NO_MOD_EXT	BOOL	R	Module missing or inoperative (Fipio extension only)	%MWr.m.MOD.2.14

Analog Device DDT

Introduction

This topic describes the Unity Pro **Analog Device DDT**.

The default device DDT name contains the following information:
- module input and or output (***X*** symbol)
- module insertion number (**#** symbol).

Example: `MOD_ANA_`***X***`_#`

The default device DDT type contains the following information:
- platform with:
  - U for unified structure between Modicon M340 and X80 or Quantum
- device type (ANA for analog)
- function (STD for standard)
  - STD for standard
  - TEMP for temperature
- direction:
  - IN
  - OUT
- max channel (2, 4, 8)

Example: For a Modicon M340 with 4 standard inputs and 2 outputs the Device Derived Data Type is T_U_ANA_STD_IN_4_OUT_2

Adjustment Parameter limitation

In Quantum EIO and M580 RIO, adjustment parameters cannot be changed from the PLC application during operation (no support of READ_PARAM, WRITE_PARAM, SAVE_PARAM, RESTORE_PARAM).

The concerned analog input parameters are:
- `FILTER_COEFF`
  Value of filter coefficient
- `ALIGNMENT_OFFSET`
  Alignment offset value
- `THRESHOLD0`
  Low threshold value
- `THRESHOLD1`
  High threshold value

The concerned analog output parameters are:
- `FALLBACK`
  Fallback value
- `ALIGNMENT`
  Alignment value

List of Device DDT

The following table shows the list of Modicon M340 and X80 devices and their corresponding device DDT name and type:

Device DDT Name	Device DDT Type	Modicon M340/X80 Devices
MOD_ANA_4_#	T_U_ANA_STD_IN_4	BMX AMI 0410
MOD_ANA_8_#	T_U_ANA_STD_IN_8	BME AHI 0812 BMX AMI 0800 BMX AMI 0810
MOD_ANA_2_#	T_U_ANA_STD_OUT_2	BMX AMO 0210
MOD_ANA_4_#	T_U_ANA_STD_OUT_4	BME AHO 0412 BMX AMO 0410
MOD_ANA_8_#	T_U_ANA_STD_OUT_8	BMX AMO 0802
MOD_ANA_6_#	T_U_ANA_STD_IN_4_OUT_2	BMX AMM 0600
MOD_ANA_4_#	T_U_ANA_TEMP_IN_4	BMX ART 0414
MOD_ANA_8_#	T_U_ANA_TEMP_IN_8	BMX ART 0814

Device DDT Instances Description

The following table shows the T_U_ANA_STD_IN_x and the T_U_ANA_STD_OUT_y status word bits:

Standard Symbol	Type	Meaning	Access
MOD_HEALTH	BOOL	0 = the module has a detected error	read
		1 = the module is operating correctly	
MOD_FLT	BYTE	internal detected errors byte of the module	read
ANA_CH_IN	ARRAY [0...x-1] of T_U_ANA_STD_CH_IN	array of structure	–
ANA_CH_OUT	ARRAY [0..y-1] of T_U_ANA_STD_CH_OUT	array of structure	–

The following table shows the T_U_ANA_STD_IN_x_OUT_y status word bits:

Standard Symbol	Type	Meaning	Access
MOD_HEALTH	BOOL	0 = the module has a detected error	read
		1 = the module is operating correctly	
MOD_FLT	BYTE	internal detected errors byte of the module	read
ANA_CH_IN	ARRAY [0..x-1] of T_U_ANA_STD_CH_IN	array of structure	–
ANA_CH_OUT	ARRAY [x..x+y-1] of T_U_ANA_STD_CH_OUT	array of structure	–

The following table shows the T_U_ANA_TEMP_IN_x status word bits:

Standard Symbol	Type	Meaning	Access
MOD_HEALTH	BOOL	0 = the module has a detected error	read
		1 = the module is operating correctly	
MOD_FLT	BYTE	internal detected errors byte of the module	read
ANA_CH_IN	ARRAY [[0..x-1] of T_U_ANA_TEMP_CH_IN	array of structure	–

The following table shows the T_U_ANA_STD_CH_IN[0..x-1] structure status word bits:

Standard Symbol		Type	Bit	Meaning	Access
FCT_TYPE		WORD	–	0 = channel is not used	read
				1 = channel is used	
CH_HEALTH		BOOL	–	0 = the channel has a detected error	read
				1 = the channel is operating correctly	
CH_WARNING		BOOL	–	not used	–
ANA		STRUCT	–	T_U_ANA_VALUE_IN	read
MEASURE_STS [INT]	CH_ALIGNED	BOOL	0	aligned channel	read
	LOWER_LIMIT	BOOL	5	measurement within lower tolerance area	read
	UPPER_LIMIT	BOOL	6	measurement within upper tolerance area	read
	INT_OFFSET_ERROR	BOOL	8	internal offset detected error	read
	IN_REF_ERROR	BOOL	10	internal reference detected error	read
	POWER_SUP_ERROR	BOOL	11	power supply detected error	read
	SPI_COM_ERROR	BOOL	12	SPI communication detected error	read

The following table shows the T_U_ANA_STD_CH_OUT[0..y-1] status word bits:

Standard Symbol	Type	Meaning	Access
MOD_HEALTH	BOOL	0 = the module has a detected error	read
		1 = the module is operating correctly	
MOD_FLT	BYTE	internal detected errors byte of the module	read
ANA_CH_OUT	ARRAY [0..y-1] of T_U_ANA_VALUE_OUT	array of structure	–

The following table shows the T_U_ANA_VALUE_IN[0..x-1] and T_U_ANA_VALUE_OUT[0..y-1] structure status word bits:

Standard Symbol	Type	Bit	Meaning	Access
VALUE	INT	–	if FORCE_CMD = 1 then VALUE = FORCED_VALUE	read(1)
			if FORCE_CMD = 0 then VALUE = TRUE_VALUE	
FORCED_VALUE	INT	–	forced value of the channel	read / write
FORCE_CMD	BOOL	–	0 = Un-force command	read / write
			1 = force command	
FORCE_STATE	BOOL	–	0 = value is not forced	read
			1 = value is forced	
TRUE_VALUE(2)	INT	–	True value of the channel (from the sensor)	read

1 VALUE of the T_U_ANA_VALUE_OUT structure word can be accessed in read / write
2 TRUE_VALUE of the T_U_ANA_VALUE_OUT is the value calculated from the application.

The following table shows the T_U_ANA_TEMP_CH_IN[0..x-1] structure status word bits:

Standard Symbol	Type	Bit	Meaning	Access
FCT_TYPE	WORD	–	0 = channel is not used	read
			1 = channel is used	
CH_HEALTH	BOOL	–	0 = the channel has a detected error	read
			1 = the channel is operating correctly	
CH_WARNING	BOOL	–	not used	–
ANA	STRUCT	–	T_U_ANA_VALUE_IN	read
MEASURE_STS	INT	–	measurement status	read
CJC_VALUE	INT	–	Cold junction compensation value (1/10 °C)	read

Use and Description of DDT for Explicit Exchange

The following table shows the DDT type used for the variables connected to dedicated EFB parameter to perform an explicit exchange:

DDT	Description	
T_M_ANA_STD_CH_STS	Structure to read the channel status of an analog module.	Depending on the I/O module location, the DDT can be connected to the STS output parameter of the EFB: ● READ_STS_QX when the module is located in Quantum EIO. ● READ_STS_MX when the module is located in a M580 local rack or in M580 RIO drops.
T_M_ANA_STD_CH_IN_STS	Structure to read the channel status of an analog output module.	
T_M_ANA_STD_CH_OUT_STS	Structure to read the channel status of an analog output module.	
T_M_ANA_TEMP_CH_STS	Structure to read the channel status of an analog temperature input module.	
T_M_ANA_STD_CH_IN_PRM	Structure for adjustment parameters of a channel of an analog input module in a M580 local rack.	The DDT can be connected to the PARAM output parameter of the EFB: ● READ_PARAM_MX to read module parameters. ● WRITE_PARAM_MX to write module parameters. ● SAVE_PARAM_MX to save module parameters. ● RESTORE_PARAM_MX to restore the new parameters of the module.
T_M_ANA_STD_CH_OUT_PRM	Structure for adjustment parameters of a channel of an analog output module in a M580 local rack.	
NOTE: Targeted channel address (ADDR) can be managed with ADDMX EF (connect the output parameter OUT to the input parameter ADDR of the communication functions).		

The following table shows the DDT structure for T_M_ANA_STD_CH_STS, T_M_ANA_STD_CH_IN_STS, T_M_ANA_STD_CH_OUT_STS and T_M_ANA_TEMP_CH_STS:

Standard Symbol		Type	Bit	Meaning	Access
CH_FLT [INT]	SENSOR_FLT	BOOL	0	detected sensor faults	read
	RANGE_FLT	BOOL	1	detected range fault	read
	CH_ERR_RPT	BOOL	2	channel detected error report	read
	INTERNAL_FLT	BOOL	4	internal detected error: module out of order	read
	CONF_FLT	BOOL	5	detected configuration fault: different hardware and software configurations	read
	COM_FLT	BOOL	6	problem communicating with the PLC	read
	APPLI_FLT	BOOL	7	detected application fault	read
	COM_FLT_ON_EVT(1)	BOOL	8	detected communication fault on event	read
	OVR_ON_CH_EVT(1)	BOOL	9	detected overrun fault on CPU event	read
	OVR_ON_CH_EVT(1)	BOOL	10	detected overrun fault on channel event	read
CH_FLT_2 [INT]	NOT_READY	BOOL	0	Channel not ready	read
	COLD_JUNCTION_FLT(2)	BOOL	1	Cold junction compensation detected error	read
	CALIB_FLT	BOOL	2	detected calibration fault	read
	INT_OFFS_FLT	BOOL	3	detected internal offset error	read
	IN_REF_FLT	BOOL	4	detected internal reference fault	read
	INT_SPI_PS_FLT	BOOL	5	detected internal serial link or power supply error	read
	RANGE_UNF	BOOL	6	recalibrated channel or range underflow	read
	RANGE_OVF	BOOL	7	aligned channel or range overflow	read

(1) only available with T_M_ANA_STD_CH_IN_STS and T_M_ANA_STD_CH_OUT_STS
(2) only available with T_M_ANA_TEMP_CH_STS

The following table shows the T_M_ANA_STD_CH_IN_PRM DDT structure:

Standard Symbol	Type	Bit	Meaning	Access
FILTERCOEFF	INT	–	Value of filter coefficient	read/write
ALIGNMENT_OFFSET	INT	–	Alignment offset value	read/write
THRESHOLD0	INT	–	Threshold 0 value **NOTE:** Fast input only	read/write
THRESHOLD1	INT	–	Threshold 1 value **NOTE:** Fast input only	read/write

The following table shows the T_M_ANA_STD_CH_OUT_PRM DDT structure:

Standard Symbol	Type	Bit	Meaning	Access
FALLBACK	INT	–	fallback value	read/write
ALIGNMENT	INT	–	alignment value	read/write

Analog Device Ethernet Remote I/O Forcing Mode

Introduction

Input and output values of Modicon M340 and X80 analog modules can be forced through the device DDT value.

NOTE: Modicon M340 and X80 discrete modules values are forced using the EB00L mechanism, refer to chapter ***Force Mode***.

Forcing input and output values in a running controller can have serious consequences to the operation of a machine or process. Only those who understand the implications in the controlling logic, and who understand the consequences of forced I/O on the machine or process, should attempt to use this function.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

You must have prior knowledge of the process, the controlled equipment and the modified behavior in Unity Pro before attempting to force analog inputs or outputs.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Modicon M340 and X80 Analog Device T_U_ANA_VALUE_•• Structure

The following table shows the content of analog devices DDT *(see page 179)* type used to force a value:

Standard Symbol	Type	Meaning
VALUE	INT	Channel value. It represents the value used in the application and is either the FORCED_VALUE or the TRUE_VALUE depending on the FORCED_STATE.
FORCED_VALUE	INT	Value applied to an output or interpreted as an input during forcing. If FORCED_STATE = 1 then VALUE = FORCED_VALUE
FORCE_CMD	BOOL	Parameter used to force or unforce an analog output or input value
FORCED_STATE	BOOL	Forcing status: • 0: value is not forced • 1: value is forced
TRUE_VALUE	INT	Represents the true value of the analog output or input whatever the state of the forcing command

Forcing a Value with the Animation Tables

To force a DDT value in an animation table proceed as follows:

Step	Action
1	Select the chosen analog channel.
2	Set the FORCED_VALUE parameter value of the selected channel to the chosen value, for details on how to set a value, refer to chapter ***Modification Mode***.
3	Set the FORCE_CMD parameter to 1.
4	**Result**: ● Check that forcing is applied: FORCED_STATE needs to be equal to 1 ● VALUE = FORCED_VALUE

Unforcing a Value with the Animation Tables

To unforce a DDT value in an animation table proceed as follows:

Step	Action
1	Select the chosen analog channel.
2	Set the FORCE_CMD parameter to 0.
3	**Result**: ● Check that forcing is released: FORCED_STATE needs to be equal to 0 ● VALUE = TRUE_VALUE

Description of HART DDT Objects

HART DDT Input Objects

The following table describes the HART DDT input objects supported by the **BME AHI 0812** analog input module and the **BME AHO 0412** analog output module.

Symbol	Size	Type	Access	Description
G_ModuleStatus	32 bits	String	Read	Module status *(see page 128)*
G_ChannelStatus	8 bytes	String	Read	Channel status *(see page 129)*[1]
G_ChannelStatus2	8 bytes	String	Read	Channel status *(see page 129)*[2]
P_Channel*N*_InstrumentStatus[3]	32 bits	String	Read/Write	Channel *N* instrument status
P_Channel*N*_PV[3]	32 bits	Float	Read	Channel *N* primary variable
P_Channel*N*_SV[3]	32 bits	Float	Read/Write	Channel *N* secondary variable
P_Channel*N*_TV[3]	32 bits	Float	Read/Write	Channel *N* tertiary variable
P_Channel*N*_QV[3]	32 bits	Float	Read/Write	Channel *N* quarternary variable
P_Channel*N*_CurrentValue[3]e	32 bits	Float	Read/Write	Channel *N* current value
P_Channel*N*_PercentValue[3]	32 bits	Float	Read/Write	Channel *N* percent value
P_Channel*N*_UpdateCounter[3]	32 bits	String	Read/Write	Channel *N* update counter

1. G_ChannelStatus contains cumulative channel status data for channels 0...3 for the:
- **BME AHI 0812** analog input module
- **BME AHO 0412** analog output module

2. G_ChannelStatus2 contains cumulative channel status data for channels 4...7 on the **BME AHI 0812** analog input module.

3. *N* represents the channel number, as follows:
- from 0...7 for the **BME AHI 0812** analog input module
- from 0...3 for the **BME AHO 0412** analog output module

HART DDT Output Objects

The following table describes the HART DDT output objects supported by the **BME AHI 0812** analog input module and the **BME AHO 0412** analog output module.

Symbol	Size	Type	Access	Description
G_ResetChanged_ID	8 bits	Byte	Read	Reset changed
CH-Enable	8 bits	Byte	Read/Write	Channel enable

Chapter 13
Operating Modules from the Application

Subject of this Chapter

This chapter explains how to operate the analog input/output modules from an application.

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
13.1	Access to the Measurements and Statuses	190
13.2	Additional Programming Features	197

Section 13.1
Access to the Measurements and Statuses

Subject of this Section

This section indicates how to configure an analog module in order to be able to access the input/outputs measurements and the various statuses.

What Is in This Section?

This section contains the following topics:

Topic	Page
Addressing of the Analog Module Objects	191
Module Configuration	193

Addressing of the Analog Module Objects

At a Glance

The addressing of the main bit and word objects of the analog input/output modules depends upon:

- the rack address
- the physical position of the module in the rack
- the module channel number

NOTE: With Unity Pro 6.1 or later and Modicon M340 firmware 2.4 or later, you can access the modules either via topological or State RAM addresses.

NOTE: Please refer to *Memory Tab* and *Topological/State RAM Addressing of Modicon M340 Analog Modules* *(see page 213)*.

Description

Addressing is defined in the following way.

%	I, Q, M, K	X, W, D, F	r	.	m	.	c	.	i	.	j
Symbol	Object type	Format	Rack		Module position		Channel no.		Rank		Word bit

The table below describes the different elements that make up addressing.

Family	Element	Meaning
Symbol	%	-
Object type	I Q	Image of the physical input of the module. Image of the physical output of the module. This information is exchanged automatically for each cycle of the task to which they are attached.
	M	Internal variable. This read or write information is exchanged at the request of the application.
	K	Internal constant. This configuration information is available as read only.
Format (size)	X	Boolean. For Boolean objects the X can be omitted.
	W	Single length.
	D	Double length.
	F	Floating point.
Rack address	r	Rack address.

Family	Element	Meaning
Module position	m	Module position number in the rack.
Channel no.	c	Channel no. 0 to 127 or MOD (MOD: channel reserved for managing the module and parameters common to all the channels).
Rank	i	Word rank. 0 to 127 or ERR (ERR: indicates an error in the word).
Word bit	j	Position of the bit in the word.

Examples

The table below shows some examples of analog object addressing.

Object	Description
%I1.3.MOD.ERR	Error information for the analog input module located in position 3 on rack 1.
%I1.4.1.ERR	Channel 1 error information for the analog input module located in position 4 on rack 1.
%IW1.2.2	Image word for the analog input 2 of the module located in position 2 on rack 1.
%QW2.4.1	Image word for the analog output 1 of the module located in position 4 on rack 2.

Module Configuration

At a Glance

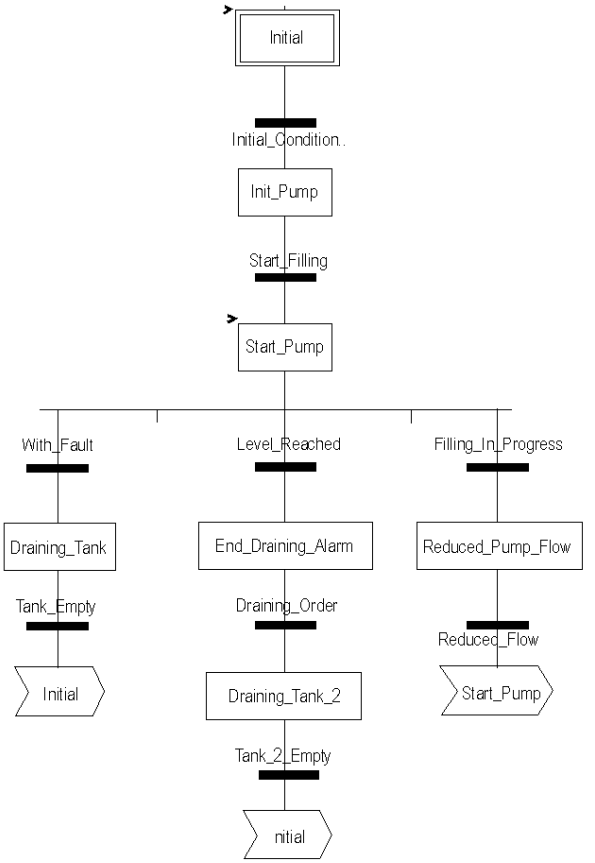
The application used here as an example manages liquid levels in a tank. The tank is filled by a pump and drained using a valve. The different levels of the tank are measured with sensors placed above the tank. The tank should not be filled with more than 100 liters of liquid.

Once the tank is full, the pump stops, and the operator drains the tank manually.

This application requires the use of a BME AHI 0812 analog input module and a BME AHO 0412 analog output module.

Tank Management Grafcet

The application grafcet is as follows:



Using the Measurements

This example configures the BME AHI 0812 analog input module to retrieve the level of the liquid in the tank.

Step	Action
1	In the **Project Browser** and in **Variables & FB instances**, double-click **Elementary variables**.
2	Create the `INT`-type variable, `Level`.
3	In the **Address** column, enter the address associated with this variable. In this example, consider that the sensor is connected to channel 0 of the BME AHI 0812 module. This module is in turn connected to slot 1 of rack 0. Therefore the address is: %MW0.1.0. Illustration:

This variable can be used to check whether the level of liquid in the tank has reached maximum level.

The following line of code can be associated with the `Level_Reached` transition of the grafcet.

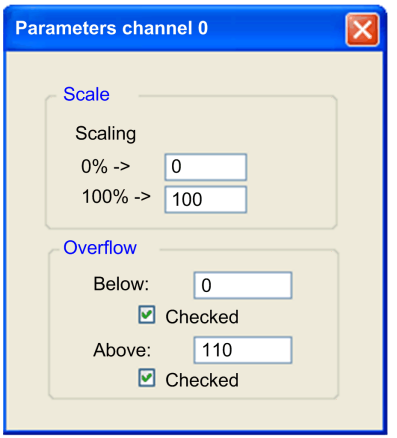
If the level of liquid in the tank reaches or exceeds the maximum level, the `Level_Reached` transition is enabled.

Using the Statuses

Program the `With_fault` transition to stop the pump in 3 cases:

- the maximum liquid level has been reached
- the pump has been stopped manually
- the measurement falls beyond the upper tolerance area

To be able to use the bit, which will indicate whether the measure still falls within the upper tolerance area (%IWr.m.c.1.6), first define the display format and scale of the channel used.

Step	Action
1	Access the hardware configuration screen for the appropriate module.
2	The range `4...20 mA` is pre-set for channel 0.
4	Access the **Parameters** dialog box for the channel in order to input the following parameters  The upper tolerance area will be 100...110 liters.
5	Confirm your changes by closing the dialog box.
6	Validate the change with **Edit** → **Validate**.

The code associated with the fault control transition looks like this:

Section 13.2
Additional Programming Features

Subject of this Section

This section presents some useful additional features for the programming of applications that use analog input/output modules.

What Is in This Section?

This section contains the following topics:

Topic	Page
Presentation of Language Objects Associated with the Analog Modules	198
Implicit Exchange Language Objects Associated with Analog Modules	199
Explicit Exchange Language Objects Associated with Analog Modules	200
Management of Exchanges and Reports with Explicit Objects	203
Language Objects Associated with Configuration	207

Presentation of Language Objects Associated with the Analog Modules

General

Analog modules are associated with different IODDTs.

The IODDTs are predefined by the manufacturer. They contain input/output language objects belonging to a channel of an analog module.

There are several distinct IODDT types for the analog module:

- `T_ANA_IN_BMX` specific to analog input modules such as the BME AHI 0812 and BMX AMI 0410, and specific to the inputs of the BMX AMM 600 mixed module
- `T_ANA_IN_T_BMX` specific to analog input modules such as the BMX ART 0414/0814
- `T_ANA_OUT_BMX` specific to analog output modules such as the BME AHO 0412 and BMX AMO 0210, and specific the outputs of the BMX AMM 600 mixed module
- `T_ANA_IN_GEN` specific to all analog input modules such as the BME AHI 0812, BMX AMI 0410, BMX ART 0414/0814, and the inputs of the BMX AMM 600 mixed module

NOTE: IODDT variables may be created in 2 ways:

- by using the **I/O Objects** tab,
- by using the data editor.

Types of Language Objects

In each IODDT, there exists a set of language objects you can use to control the modules and check their correct operation.

There are 2 types of language objects:

- **Implicit Exchange Objects**, which are automatically exchanged at each cycle of the task assigned to the module. They concern the inputs/outputs of the module (measurement results, information, commands, and so forth).
- **Explicit Exchange Objects**, which are exchanged at the application request, using explicit exchange instructions. They are used to set the module and perform diagnostics.

Implicit Exchange Language Objects Associated with Analog Modules

At a Glance

An integrated interface or the addition of a module automatically enhances the language objects application used to program this interface or module.

These objects correspond to the input/output images and software data of the module or integrated interface.

Reminders

The module inputs (%I and %IW) are updated in the PLC memory at the start of the task, the PLC being in RUN or STOP mode.

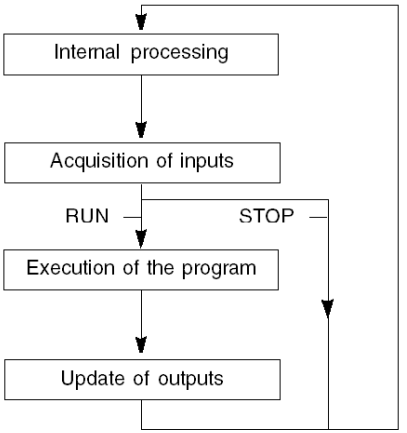
The outputs (%Q and %QW) are updated at the end of the task, only when the PLC is in RUN mode.

NOTE: When the task occurs in STOP mode, either of the following are possible, depending on the configuration selected:

- Outputs are set to fallback position (fallback mode).
- Outputs are maintained at their last value (maintain mode).

Illustration

The operating cycle of a PLC task (cyclical execution) looks like this:



Explicit Exchange Language Objects Associated with Analog Modules

Introduction

Explicit exchanges are performed at the user program's request, using the following instructions:

- READ_STS: read status words
- WRITE_CMD: write command words
- WRITE_PARAM: write adjustment parameters
- READ_PARAM: read adjustment parameters
- SAVE_PARAM: save adjustment parameters
- RESTORE_PARAM: restore adjustment parameters

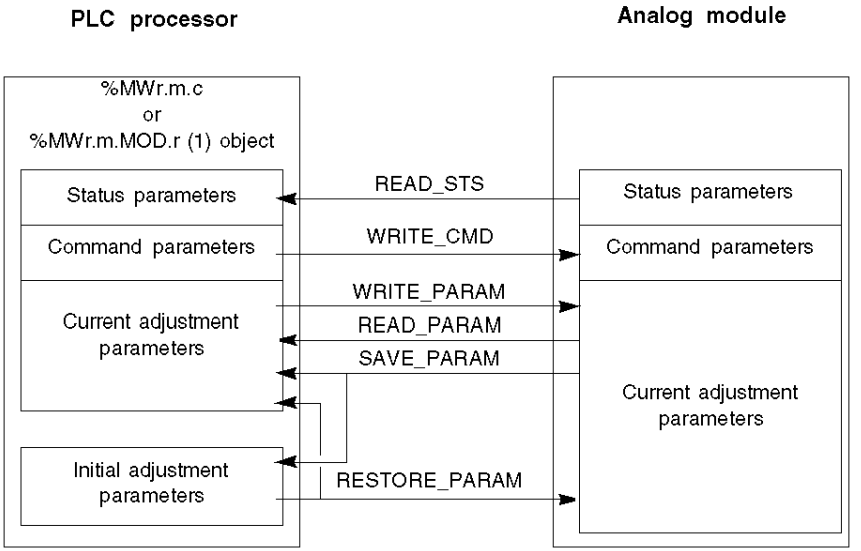
These exchanges apply to a set of %MW objects of the same type (status, commands, or parameters) that belong to a channel.

NOTE: These objects provide information about the module (e.g.: error type for a channel, etc.) and can be used to command them (e.g.: switch command) and to define their operating modes (save and restore currently applied adjustment parameters).

NOTE: You can not send the WRITE_PARAM and RESTORE_PARAM requests at the same time to the channels managed by the same logical nodes, The logical node can only process one request, the other request will generate an error.To avoid this kind of errors you have to manage the exchange for each channel with %MWr.m.c.0.x and %MWr.m.c.1.x.

General Principle for Using Explicit Instructions

The diagram below shows the different types of explicit exchanges that can be made between the processor and module.



(1) Only with READ_STS and WRITE_CMD instructions.

Example of Using Instructions

READ_STS instruction:

The READ_STS instruction is used to read SENSOR_FLT (%MWr.m.c.2) and NOT_READY (%MWr.m.c.3) words. It is therefore possible to determine with greater precision the errors which may have occurred during operation.

Performing a READ_STS of all the channels would result in overloading of the PLC. A less burdensome method would be to test the error bit of all the modules in each cycle, and then the channels of the modules in question. You would then only need to use the READ_STS instruction on the address obtained.

The algorithm could look like this:

```
WHILE (%I0.m.ERR <> 1) OR (m <= Number of modules) THEN
  m=m+1
  Loop
END WHILE

WHILE (%I0.m.c.ERR <> 1) OR (c <= Number of channels) THEN
  c=c+1
  Loop
END WHILE

READ_STS (%I0.m.c)
```

WRITE_PARAM instruction:

The WRITE_PARAM instruction is used to modify certain configuration parameters for the modules during operation.

All you need to do is to assign the new values to the relevant objects and use the WRITE_PARAM instruction on the required channel.

For example, you can use this instruction to modify the fallback value by program (only for output analog modules). Assign the required value to the Fallback (%MWr.m.c.7) word and then use the WRITE_PARAM instruction.

Management of Exchanges and Reports with Explicit Objects

At a Glance

When data is exchanged between the PLC memory and the module, the module may require several task cycles to acknowledge this information. All IODDTs use two words to manage exchanges:

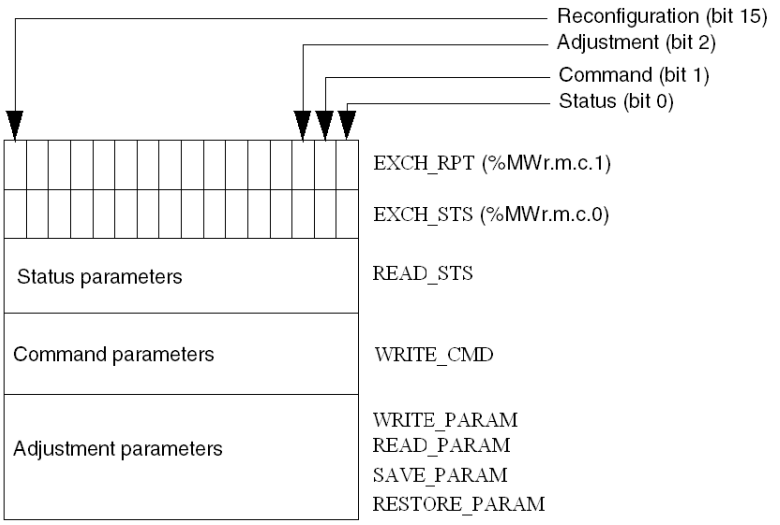
- EXCH_STS (%MWr.m.c.0) : exchange in progress
- EXCH_RPT (%MWr.m.c.1) : report

NOTE: Depending on the localization of the module, the management of the explicit exchanges(%MW0.0.MOD.0.0 for example) will not be detected by the application:

- for in-rack modules, explicit exchanges are doneimmediately on the local PLC Bus and are finished before the end of the executon task, so the READ_STS, for example, is always finished when the %MW0.0.mod.0.0 bit is checked by the application.
- for remote bus (Fipio for example), explicit exchanges are not synchronous with the execution task, so the detection is possible by the application.

Illustration

The illustration below shows the different significant bits for managing exchanges.



Description of Significant Bits

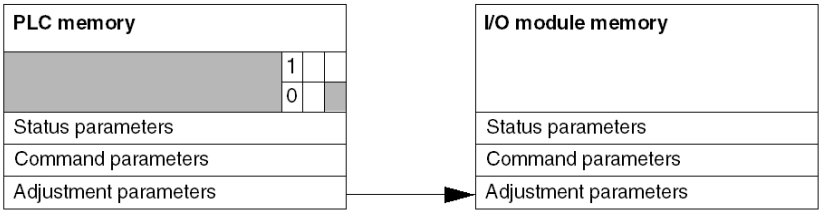
Each bit of the EXCH_STS (%MWr.m.c.0) and EXCH_RPT (%MWr.m.c.1) words is associated with a type of parameter:

- Rank 0 bits are associated with the status parameters:
  - The STS_IN_PROGR bit (%MWr.m.c.0.0) indicates whether a read request for the status words is in progress.
  - The STS_ERR bit (%MWr.m.c.1.0) specifies whether a read request for the status words is accepted by the module channel.
- Rank 1 bits are associated with the command parameters:
  - The CMD_IN_PROGR bit (%MWr.m.c.0.1) indicates whether command parameters are being sent to the module channel.
  - The CMD_ERR bit (%MWr.m.c.1.1) specifies whether the command parameters are accepted by the module channel.
- Rank 2 bits are associated with the adjustment parameters:
  - The ADJ_IN_PROGR bit (%MWr.m.c.0.2) indicates whether the adjustment parameters are being exchanged with the module channel (via WRITE_PARAM, READ_PARAM, SAVE_PARAM, RESTORE_PARAM).
  - The ADJ_ERR bit (%MWr.m.c.1.2) specifies whether the adjustment parameters are accepted by the module. If the exchange is correctly executed, the bit is set to 0.
- Rank 15 bits indicate a reconfiguration on channel c of the module from the console (modification of the configuration parameters and cold start-up of the channel).
- Bits r, m, and c indicate the following slots:
  - Bit r represents the rack number.
  - Bit m represents the position of the module in the rack.
  - Bit c represents the channel number in the module.

NOTE: Exchange and report words also exist at the level of EXCH_STS (%MWr.m.MOD.0) and EXCH_RPT (%MWr.m.MOD.1) modules, as per T_ANA_IN_BMX, T_ANA_IN_T_BMX and T_ANA_OUT_BMX-type IODDTs.

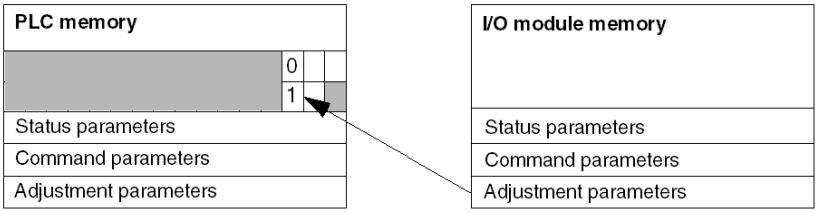
Example

Phase 1: Sending data by using the WRITE_PARAM instruction:



When the instruction is scanned by the PLC processor, the `Exchange in progress` bit is set to 1 in `%MWr.m.c`.

Phase 2: Analysis of the data by the input/output module and report:



When data is exchanged between the PLC memory and the module, acknowledgement by the module is managed by the `ADJ_ERR` (`%MWr.m.c.1.2`) bit which, depending on its value, gives the following report:

- **0:** correct exchange.
- **1:** error in exchange.

NOTE: There is no adjustment parameter at module level.

Explicit Exchange Execution Flag: EXCH_STS

The table below shows the `EXCH_STS` (`%MWr.m.c.0`) explicit exchange control bits.

Standard symbol	Type	Access	Meaning	Address
STS_IN_PROGR	BOOL	R	Reading of channel status words in progress	%MWr.m.c.0.0
CMD_IN_PROGR	BOOL	R	Command parameters exchange in progress	%MWr.m.c.0.1
ADJ_IN_PROGR	BOOL	R	Adjust parameters exchange in progress	%MWr.m.c.0.2
RECONF_IN_PROGR	BOOL	R	Reconfiguration of the module in progress	%MWr.m.c.0.15

NOTE: If the module is not present or is disconnected, explicit exchange objects (`READ_STS`, for example) are not sent to the module (`STS_IN_PROG` (`%MWr.m.c.0.0) = 0`), but the words are refreshed.

Explicit Exchange Report: EXCH_RPT

The table below presents the EXCH_RPT (%MWr.m.c.1) report bits.

Standard symbol	Type	Access	Meaning	Address
STS_ERR	BOOL	R	Error reading channel status words (1 = error)	%MWr.m.c.1.0
CMD_ERR	BOOL	R	Error during a command parameter exchange (1 = error)	%MWr.m.c.1.1
ADJ_ERR	BOOL	R	Error while exchanging adjustment parameters (1 = error)	%MWr.m.c.1.2
RECONF_ERR	BOOL	R	Error during reconfiguration of the channel (1 = error)	%MWr.m.c.1.15

Language Objects Associated with Configuration

At a Glance

The configuration of an analog module is stored in the configuration constants (%KW).

The parameters r, m, and c shown in the following tables represent the topologic addressing of the module. Each parameter had the following signification:

- **r:** represents the rack number
- **m:** represents the position of the module on the rack
- **c:** represents the channel number

BME AHI 0812, BMX AMI 0410, BMX AMI 0800, and BMX AMI 0810 Configuration Objects and Inputs of BMX AMM 0600

The process control language objects associated to the configuration of the BME AHI 0812, BMX AMI 0410, BMX AMI 0800, and BMX AMI 0810 modules include the following:

Addresses	Description	Bits Meaning
%KWr.m.c.0	Channel range configuration	**Bit 0 to 5:** electric range (hexadecimal value) **Bit 7:** 0=electrical range (always 0)
%KWr.m.c.1	Scale/User scaling min value	-
%KWr.m.c.2	Scale/User scaling max value	-
%KWr.m.c.3	Over range below value	-
%KWr.m.c.4	Over range above value	-
%KWr.m.c.5	Channel treatment configuration	**Bit 0:** 0=Mast mode, 1=Fast mode **Bit 1:** 0=channel disabled, 1=channel enabled **Bit 2:** 0=sensor monitor off, 1=sensor monitor on **Bit 7:** 0=Manufacturer scale, 1=user scale **Bit 8:** over range lower threshold enabled **Bit 9:** over range upper threshold enabled

BMX ART 0414/0814 Configuration Objects

The process control language objects associated to the configuration of the BMX ART 0414/0814 modules include the following:

Addresses	Description	Bits Meaning
%KWr.m.c.0	Channel range configuration	**Bit 0 to 5:** Temperature range (hexadecimal value) **Bit 6:** Temperature range (0=°C, 1=F°) **Bit 7:** 1=Temperature range **Bit 8:** 0=rejection 50 Hz, 1=rejection 60 Hz
%KWr.m.c.1	Scale/User scaling min value	-
%KWr.m.c.2	Scale/User scaling max value	-
%KWr.m.c.3	Over range below value	-
%KWr.m.c.4	Over range above value	-
%KWr.m.c.5	Channel treatment configuration	**Bit 0:** 0=Standard mode (always 0) **Bit 1:** 0=channel disabled (only in Fast mode), 1=channel enabled **Bit 2:** 0=sensor monitor off, 1=sensor monitor on **Bits 3 to 6:** CJC Configuration Mode for channels 0/3: ● Bit 3=0 and Bit 4=0: Int. Telefast, ● Bit 3=1 and Bit 4=0: External RTD, ● Bit 3=0 and Bit 4=1: CJC on channels 4/7. **Bits 3 to 6:** CJC Configuration Mode for channels 4/7: ● Bit 5=0 and Bit 6=0: Int. Telefast, ● Bit 5=1 and Bit 6=0: External RTD. **Bit 7:** 0=Manufacturer scale, 1=user scale **Bit 8:** Over range lower threshold enabled **Bit 9:** Over range upper threshold enabled

BME AHO 0412, BMX AMO 0210, BMX AMO 0410, and BMX AMO 0802 Configuration Objects and Outputs of BMX AMM 0600

The process control language objects associated to the configuration of the BME AHO 0412, BMX AMO 0210, BMX AMO 0410, and BMX AMO 0802 modules include the following:

Addresses	Description	Bits Meaning
%KWr.m.c.0	Channel range configuration	**Bit 0 to 5:** Electric range (hexadecimal value) **Bit 8:** Fallback mode (0=Fallback, 1=Maintain) **Bit 11:** Actuator wiring control (0=disabled, 1=enabled) **Bit 14:** Output lower overshoot below range valid (0=disabled, 1=enabled) **Bit 15:** Output upper overshoot above range valid (0=disabled, 1=enabled)
%KWr.m.c.1	Scale/User scaling min value	-
%KWr.m.c.2	Scale/User scaling max value	-
%KWr.m.c.3	Overshoot below value	-
%KWr.m.c.4	Overshoot above value	-

Appendices

Overview

These appendices contain information that should be useful for programming the application.

What Is in This Appendix?

The appendix contains the following chapters:

Chapter	Chapter Name	Page
A	Topological/State RAM Addressing of the Modules	213
B	EtherNet/IP Communication Codes	215

Appendix A
Topological/State RAM Addressing of the Modules

Topological/State RAM Addressing of Modicon M340 and X80 Analog Modules

Analog Modules

With Unity Pro 6.1 or later and Modicon M340 firmware 2.4 or later, you can access the modules either via topological or State RAM addresses. Please also refer to *Memory Tab*.

The following table shows the Modicon M340 and X80 analog module objects that can be mapped to topological or State RAM addresses.

Module reference	Topological address	State RAM address
BMX AHI 0812	%IW rack.slot.channel, channel [0,7]	-%IWStart address ... %IWStart address + 7
BMX AHO 0412	%QW rack.slot.channel, channel [0,3]	-%MWStart address ... %MWStart address + 3
BMX AMI 0410	%IW rack.slot.channel, channel [0,3]	-%IWStart address ... %IWStart address + 3
BMX AMI 0800	%IW rack.slot.channel, channel [0,7]	-%IWStart address ... %IWStart address + 7
BMX AMI 0810	%IW rack.slot.channel, channel [0,7]	-%IWStart address ... %IWStart address + 7
BMX AMM 0600	%IW rack.slot.channel, channel [0,3] %QW rack.slot.channel, channel [4,5]	-%IWStart address ... %IWStart address + 3 and -%MWStart address ... %MWStart address + 1
BMX AMO 0210	%QW rack.slot.channel, channel [0,1]	-%MWStart address ... %MWStart address +1
BMX AMO 0410	%QW rack.slot.channel, channel [0,3]	-%MWStart address ... %MWStart address + 3
BMX AMO 0802	%QW rack.slot.channel, channel [0,7]	-%MWStart address ... %MWStart address + 7
BMX ART 0414	%IW rack.slot.channel, channel [0,3]	-Value: -%IWStart address ... %IWStart address + 3 -Cold junction: -%IWStart address + 4
BMX ART 0814	%IW rack.slot.channel, channel [0,7]	-%IWStart address ... %IWStart address + 7 -Cold junction, ch 0-3: %IWStart address + 8 -Cold junction, ch 4-7: %IWStart address + 9

For additional information please refer to *Special Conversion for Compact I/O Modules*.

Appendix B
EtherNet/IP Communication Codes

Overview

This chapter presents EtherNet/IP Communication codes.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Explicit Messaging: Communication and Operation Reports	216
CIP General Status Codes	219
EtherNet/IP Implicit or Explicit Messaging Detected Error Codes	222

Explicit Messaging: Communication and Operation Reports

Overview

Communication and operation reports are part of the management parameters.

NOTE: It is recommended that communication function reports be tested at the end of their execution and before the next activation. On cold start-up, confirm that all communication function management parameters are checked and reset to 0.

NOTE: It may be helpful to use the %S21 to examine the first cycle after a cold or warm start. For more information, refer to Unity Pro online help for %S21.

Communication Report

This report is common to every explicit messaging function. It is significant when the value of the activity bit switches from 1 to 0. The reports with a value between 16#01 and 16#FE concern errors detected by the processor that executed the function.

The different values of this report are indicated in the following table:

Value	Communication report (least significant byte)
16#00	Correct exchange
16#01	Exchange stop on timeout
16#02	Exchange stop on user request (CANCEL)
16#03	Incorrect address format
16#04	Incorrect destination address
16#05	Incorrect management parameter format
16#06	Incorrect specific parameters
16#07	Error detected in sending to the destination
16#08	Reserved
16#09	Insufficient receive buffer size
16#0A	Insufficient send buffer size
16#0B	No system resources: the number of simultaneous communication EFs exceeds the maximum that can be managed by the processor
16#0C	Incorrect exchange number
16#0D	No telegram received
16#0E	Incorrect length
16#0F	Telegram service not configured
16#10	Network module missing
16#11	Request missing
16#12	Application server already active

Value	Communication report (least significant byte)
16#13	UNI-TE V2 transaction number incorrect
16#FF	Message refused

NOTE: The function can detect a parameter error before activating the exchange. In this case the activity bit remains at 0, and the report is initialized with values corresponding to the detected error.

Operation Report

This report byte is specific to each function, and specifies the result of the operation on the remote application:

Value	Operation report (most significant byte)
16#05	Length mismatch (CIP)
16#07	Bad IP address
16#09	Network is down
16#0A	Connection reset by peer
16#0C	Communication function not active
16#0D	• Modbus TCP: transaction timed out • EtherNet/IP: request timeout
16#0F	No route to remote host
16#13	Connection refused
16#15	• Modbus TCP: no resources • EtherNet/IP: no resources to handle the message; or an internal detected error; or no buffer available; or no link available; or cannot send message
16#16	Remote address not allowed
16#18	• Modbus TCP: concurrent connections or transactions limit reached • EtherNet/IP: TCP connection or encapsulation session in progress
16#19	Connection timed out
16#30	• Modbus TCP: remote host is down • EtherNet/IP: connection open timed out
16#80...16#87: Forward_Open response detected errors:	
16#80	Internal detected error
16#81	Configuration detected error: the length of the explicit message, or the RPI rate, needs to be adjusted
16#82	Device detected error: target device does not support this service
16#83	Device resource detected error: no resource is available to open the connection
16#84	System resource evebt: unable to reach the device
16#85	Data sheet detected error: incorrect EDS file
16#86	Invalid connection size

Value	Operation report (most significant byte)
16#90...16#9F: Register session response detected errors:	
16#90	Target device does not have sufficient resources
16#98	Target device does not recognize message encapsulation header
16#9F	Unknown detected error from target

CIP General Status Codes

NOTE: Taken by permission from *The CIP Networks Library, Volume 1*, Common Industrial Protocol (CIP™), Edition 3.6, April 2009.

The following table lists the status codes that may be present in the general status code field of a detected error response message. Note that the extended code field is available for use in further describing any general status code. Extended status codes are unique to each general status code within each object. Each object manages the extended status values and value ranges (including vendor specific). All extended status values are reserved unless otherwise indicated within the object definition.

General Status Code (in hex)	Status Name	Description of Status
00	Success	Service was successfully performed by the object specified.
01	Connection unsuccessful	A connection related service was unsuccessful along the connection path.
02	Resource unavailable	Resources needed for the object to perform the requested service were unavailable.
03	Invalid parameter value	See status code 0x20, which is the preferred value to use for this condition.
04	Path segment error	The path segment identifier or the segment syntax was not understood by the processing node. Path processing stops when a path segment error is detected.
05	Path destination unknown	The path is referencing an object class, instance, or structure element that is not known or is not contained in the processing node. Path processing stops when a path destination unknown error is detected.
06	Partial transfer	Only part of the expected data was transferred.
07	Connection lost	The messaging connection was lost.
08	Service not supported	The requested service was not implemented or was not defined for this object class/instance.
09	Invalid attribute value	Invalid attribute data detected.
0A	Attribute list error	An attribute in the Get_Attribute_List or Set_Attribute_List response has a non-zero status.
0B	Already in requested mode/state	The object is already in the mode/state being requested by the service.
0C	Object state conflict	The object cannot perform the requested service in its current mode/state.
0D	Object already exists	The requested instance of object to be created already exists.

General Status Code (in hex)	Status Name	Description of Status
0E	Attribute not settable	A request to modify a non-modifiable attribute was received.
0F	Privilege violation	A permission/privilege check was unsuccessful.
10	Device state conflict	The device's current mode/state prohibits the execution of the requested service.
11	Reply data too large	The data to be transmitted in the response buffer is larger than the allocated response buffer.
12	Fragmentation of a primitive value	The service specified an operation that is going to fragment a primitive data value, i.e., half a REAL data type.
13	Not enough data	The service did not supply enough data to perform the specified operation.
14	Attribute not supported	The attribute specified in the request is not supported.
15	Too much data	The service supplied more data than was expected.
16	Object does not exist	The object specified does not exist in the device.
17	Service fragmentation sequence not in progress	The fragmentation sequence for this service is not currently active for this data.
18	No stored attribute data	The attribute data of this object was not saved prior to the requested service.
19	Store operation unsuccessful	The attribute data of this object was not saved due to an unsuccessful attempt.
1A	Routing unsuccessful, request packet too large	The service request package was too large for transmission on a network in the path to the destination. The routing device was forced to abort the service.
1B	Routing unsuccessful, response packet too large	The service response packet was too large for transmission on a network in the path from the destination. The routing device was forced to abort the service.
1C	Missing attribute list entry data	The service did not supply an attribute in a list of attributes that was needed by the service to perform the requested behavior.
1D	Invalid attribute value list	The service is returning the list of attributes supplied with status information for those attributes that were invalid.
1E	Embedded service error	An embedded service resulted in a detected error.
1F	Vendor specific error	A vendor specific error has been detected. The additional code field of the error response defines the particular error encountered. Use this general code only when none of the codes presented in this table or within an object class definition accurately reflect the detected error.

General Status Code (in hex)	Status Name	Description of Status
20	Invalid parameter	A parameter associated with the request was invalid. This code is used when a parameter does not meet the requirements of this specification and/or the requirements defined in an application object specification.
21	Write-once value or medium already written	An attempt was made to write to a write-once medium (e.g., WORM drive, PROM) that has already been written, or to modify a value that cannot be changed once established.
22	Invalid reply received	An invalid reply is received (e.g., reply service code does not match the request service code, or reply message is shorter than the minimum expected reply size). This status code an serve for other causes of invalid replies.
23	Buffer overflow	The message received is larger than the receiving buffer can handle. The entire message was discarded.
24	Message format error	The format of the received message is not supported by the server.
25	Key failure in path	The key segment that was included as the first segment in the path does not match the destination module. The object specific status indicates which part of the key check was unsuccessful.
26	Path size invalid	The size of the path that was sent with the service request is either not large enough to allow the request to be routed to an object or too much routing data was included.
27	Unexpected attribute in list	An attempt was made to set an attribute that is not able to be set at this time.
28	Invalid member ID	The member ID specified in the request does not exist in the specified class/instance/attribute.
29	Member not settable	A request to modify a non-modifiable member was received.
2A	Group 2 only server — general error	This detected error code may only be reported by DeviceNet group 2 only servers with 4 Kb or less code space and only in place of service not supported, attribute not support, or attribute not settable.
2B	Unknown Modbus error	A CIP to Modbus translator received an unknown Modbus exception code.
2C	Attribute not gettable	A request to read a non-readable attribute was received.
2D - CF	–	Reserved by CIP for future extensions.
D0 - FF	Reserved for object class and service errors	This range of detected error codes is used to indicate object class specific detected errors. Use this range only when none of the codes presented in this table accurately reflect the error that is detected.

EtherNet/IP Implicit or Explicit Messaging Detected Error Codes

Introduction

If a DATA_EXCH function block does not execute an EtherNet/IP explicit message, Unity Pro returns a hexadecimal detected error code. The code can describe an EtherNet/IP detected error.

EtherNet/IP Detected Error Codes

EtherNet/IP hexadecimal detected error codes include:

Detected Error Code	Description
16#800D	Timeout on the explicit message request
16#8015	Either: ● Nor resources to handle the message, or ● Internal detected error: no buffer available, no link available, impossible to send to the TCP task
16#8018	Either: ● Another explicit message for this device is in progress, or ● TCP connection or encapsulation session in progress
16#8030	Timeout on the Forward_Open request
Note: The following 16#81xx detected errors are Forward_Open response detected errors that originate at the remote target and are received via the CIP connection.	
16#8100	Connection in use or duplicate Forward_Open
16#8103	Transport class and trigger combination not supported
16#8106	Ownership conflict
16#8107	Target connection not found
16#8108	Invalid network connection parameter
16#8109	Invalid connection size
16#8110	Target for connection not configured
16#8111	RPI not supported
16#8113	Out of connections
16#8114	Vendor ID or product code mismatch
16#8115	Product type mismatch
16#8116	Revision mismatch
16#8117	Invalid produced or consumed application path
16#8118	Invalid or inconsistent configuration application path
16#8119	Non-Listen Only connection not opened
16#811A	Target object out of connections

Detected Error Code	Description
16#811B	RPI is smaller than the production inhibit time
16#8123	Connection timed out
16#8124	Unconnected request timed out
16#8125	Parameter detected error in unconnected request and service
16#8126	Message too large for unconnected_send service
16#8127	Unconnected acknowledge without reply
16#8131	No buffer memory available
16#8132	Network bandwidth not available for data
16#8133	No consumed connection ID filter available
16#8134	Not configured to send scheduled priority data
16#8135	Schedule signature mismatch
16#8136	Schedule signature validation not possible
16#8141	Port not available
16#8142	Link address not valid
16#8145	Invalid segment in connection path
16#8146	detected error in Forward_Close service connection path
16#8147	Scheduling not specified
16#8148	Link address to self invalid
16#8149	Secondary resources unavailable
16#814A	Rack connection already established
16#814B	Module connection already established
16#814C	Miscellaneous
16#814D	Redundant connection mismatch
16#814E	No more user-configurable link consumer resources: the configured number of resources for a producing application has reached the limit
16#814F	No more user-configurable link consumer resources: there are no consumers configured for a producing application to use
16#8160	Vendor specific
16#8170	No target application data available
16#8171	No originator application data available
16#8173	Not configured for off-subnet multicast
16#81A0	detected error in data assignment
16#81B0	Optional object state detected error
16#81C0	Optional device state detected error

Detected Error Code	Description
Note: All 16#82xx detected errors are register session response detected errors.	
16#8200	Target device does not have sufficient resources
16#8208	Target device does not recognize message encapsulation header
16#820F	Reserved or unknown detected error from target

Glossary

0-9

%I

According to the IEC standard, `%I` indicates a discrete input-type language object.

%IW

According to the IEC standard, `%IW` indicates an analog input-type language object.

%M

According to the IEC standard, `%M` indicates a memory bit-type language object.

%MW

According to the IEC standard, `%MW` indicates a memory word-type language object.

%Q

According to the IEC standard, `%Q` indicates a discrete output-type language object.

%QW

According to the IEC standard, `%QW` indicates an analog output-type language object.

A

adapter

The target of real-time I/O data connection requests from scanners. It cannot send or receive real-time I/O data unless it is configured to do so by a scanner, and it does not store or originate the data communications parameters necessary to establish the connection. An adapter accepts explicit message requests (connected and unconnected) from other devices.

analog input

A module that contains circuits that convert analog input signals to digital values that can be manipulated by the processor. By implication, these analog inputs are usually direct. That means a data table value directly reflects the analog signal value.

analog output

A module that contains circuits that transmit an analog signal proportional to a digital value input to the module from the processor. By implication, these analog outputs are usually direct. That means a data table value directly controls the analog signal value.

asset management software

A software application that can configure, monitor, and manage devices employed as part of an industrial automation system.

asynchronous

Communication mode typified by the absence of a global, fixed-rate clock signal. Instead, asynchronous communication control is spread among multiple devices, that communicate and synchronize over shared channels.

auto addressing

The automatic assignment of an address to each island bus I/O module.

auto configuration

The ability of island modules to operate with predefined default parameters. A configuration of the island bus based completely on the actual assembly of I/O modules.

B

Bell 202 FSK standard

A standard defining the operation of *frequency shift keying:* a frequency modulation scheme that transmits digital information by means of discrete frequency changes in a carrier wave.

BootP

Bootstrap Protocol: A UDP network protocol that can be used by a network client to automatically obtain an IP address from a server. The client identifies itself to the server using its MAC address. The server, which maintains a pre-configured table of client device MAC addresses and associated IP addresses, sends the client its defined IP address. The BOOTP service utilizes UDP ports 67 and 68.

C

CCOTF

(*change configuration on the fly*) A feature of Unity Pro that allows a PLC hardware change in the system configuration while the PLC is operating and not impacting other active drop operations.

CIP™

(*common industrial protocol*) A comprehensive suite of messages and services for the collection of manufacturing automation applications — control, safety, synchronization, motion, configuration and information. CIP allows users to integrate these manufacturing applications with enterprise-level Ethernet networks and the internet. CIP is the core protocol of EtherNet/IP.

class 1 connection

A CIP transport connection used for I/O data transmission via implicit messaging between EtherNet/IP devices.

class 3 connection

A CIP transport connection used for explicit messaging between EtherNet/IP devices.

configuration

The arrangement and interconnection of hardware components within a system, and the hardware and software settings that determine the operating characteristics of the system.

current loop

An analog electrical signaling scheme, that allows a device to be monitored or controlled over a pair of conductors. Only one current level can exist in a current loop at any point in time. A digital signal can be added to the analog current loop using the HART protocol, enabling additional communication with the analog device.

D

DDL

Device Description Language file: A definitional template for a HART field instrument, that describes its configurable parameters, the data that it can produce, and its operating procedures, including menus, commands and display formats.

DDT

(*derived data type*) A set of elements with the same type (`array`) or with different types (structure).

device name

A user-defined, unique identifier for an Ethernet device. After the device is configured with a valid device name, a DHCP server can use it to identify the device and provide it with an IP address at power up.

DHCP

(*dynamic host configuration protocol*) An extension of the BOOTP communications protocol that provides for the automatic assignment of IP addressing settings—including IP address, subnet mask, gateway IP address, and DNS server names. DHCP does not require the maintenance of a table identifying each network device. The client identifies itself to the DHCP server using either its MAC address, or a uniquely assigned device identifier. The DHCP service utilizes UDP ports 67 and 68.

DIN

Deutsche Industrial Norms. A German agency that sets engineering and dimensional standards and now has worldwide recognition.

DTM

(*device type manager*) A device driver running on the host PC. It provides a unified structure for accessing device parameters, configuring and operating the devices, and troubleshooting the network. DTMs can range from a simple graphical user interface (GUI) for setting device parameters to a highly sophisticated application capable of performing complex real-time calculations for diagnosis and maintenance purposes. In the context of a DTM, a device can be a communications module or a remote device on the network.

See *FDT*.

E

EDS

(*electronic data sheet*) Simple text files that describe the configuration capabilities of a device. EDS files are generated and maintained by the manufacturer of the device.

EIA

Electronic Industries Association: An organization that establishes electrical/electronic and data communication standards.

EMC

electromagnetic compatibility: Devices that meet EMC requirements can operate within a system's expected electromagnetic limits without interruption.

EMI

electromagnetic interference: EMI can cause an interruption or disturbance in the performance of electronic equipment. It occurs when a source electronically transmits a signal that interferes with other equipment. Also known as radio frequency interference (RFI).

Ethernet

A 10 Mb/s, 100 Mb/s, or 1 Gb/s, CSMA/CD, frame-based LAN that can run over copper twisted pair or fiber optic cable, or wireless. The IEEE standard 802.3 defines the rules for configuring a wired Ethernet network; the IEEE standard 802.11 defines the rules for configuring a wireless Ethernet network. Common forms include 10BASE-T, 100BASE-TX, and 1000BASE-T, which can utilize category 5e copper twisted pair cables and RJ45 modular connectors.

explicit messaging

TCP/IP-based messaging for Modbus TCP and EtherNet/IP. It is used for point-to-point, client/server messages that include both data—typically unscheduled information between a client and a server—and routing information. In EtherNet/IP, explicit messaging is considered class 3 type messaging, and can be connection-based or connectionless.

F

fallback state

A known state to which an output module can return in the event that it loses communication with the PLC.

FDR

(*fast device replacement*) A service that uses configuration software to replace an inoperable device.

FE

functional ground: A grounded supply conductor, often carrying current, that is used to enhance the operation of equipment. Contrast: *protective ground (PE)*.

Flash memory

Nonvolatile memory that can be overwritten. It is stored on an EEPROM that can be erased and reprogrammed.

FTP

(*file transfer protocol*) A protocol that copies a file from one host to another over a TCP/IP-based network, such as the internet. FTP uses a client-server architecture as well as separate control and data connections between the client and server.

full duplex

The ability of 2 networked devices to independently and simultaneously communicate with each other in both directions.

H

half duplex

A system of communication between 2 networked devices that provides for transmissions in both directions, but in only one direction at a time.

HART

Highway Addressable Remote Transducer protocol: A bi-directional communication protocol for transmitting—across analog wires—digital information between intelligent field devices and a host control/monitoring system. For more information, refer to the *HART Communication Foundation* web site: www.hartcomm.org.

HART interface module

A modem that serves as the pass through device between one or more HART master devices, and multiple HART slave devices.

HART master

A HART host application, typically resident in a PC. For example, asset management software.

HART slave

A HART compliant smart field device, which responds via the HART protocol only when commanded to do so by a HART master.

high pass filter

A frequency-based filter that permits transmissions only above a pre-set frequency threshold to pass. In HART, the frequency threshold is typically set in range of 400...800 Hz: transmissions above this threshold—HART digital signals—are allowed to pass through; transmissions beneath this threshold are filtered.

HMI

(*human machine interface*) An HMI is a device that displays process data to a human operator, who in turn uses the HMI to control the process.

An HMI is typically connected to a SCADA system to provide diagnostics and management data — such as scheduled maintenance procedures and detailed schematics for a particular machine or sensor.

hot swapping

Replacing a component with a like component while the system remains operational. When the replacement component is installed, it begins to function automatically.

HTTP

(*hypertext transfer protocol*) A networking protocol for distributed and collaborative information systems. HTTP is the basis of data communication for the web.

I

I/O module

In a programmable controller system, an I/O module interfaces directly to the sensors and actuators of the machine/process. This module provides electrical connections between the controller and the field devices.

IEC

International Electrotechnical Commission Carrier: Founded in 1884 to focus on advancing the theory and practice of electrical, electronics and computer engineering, and computer science. EN 61131-2 is the specification that deals with industrial automation equipment.

IEEE

Institute of Electrical and Electronics Engineers, Inc.: The international standards and conformity assessment body for all fields of electrotechnology, including electricity and electronics.

implicit messaging

UDP/IP-based class 1 connected messaging for EtherNet/IP. Implicit messaging maintains an open connection for the scheduled transfer of control data between a producer and consumer. Because an open connection is maintained, each message contains primarily data — without the overhead of object information — and a connection identifier.

IP

Internet Protocol: That part of the TCP/IP protocol family that tracks the internet addresses of nodes, routes outgoing messages, and recognizes incoming messages.

IP rating

ingress protection rating: A standardized approach to establishing the degree to which a device resists the ingress of particles and water, as defined by IEC 60529. For example:

- IP20 requires that a device not permit the ingress and contact of objects larger than 12.5 mm (0.49 in). The standard does not require resistance to ingress by water.
- IP67 requires that a device completely resist the ingress of dust and contact by objects. The standard requires that no Ingress of water in harmful quantity be permitted when the enclosure is immersed in water up to 1 m (39.37 in).

L

low pass filter

A frequency-based filter that permits transmissions only below a pre-set frequency threshold to pass. In HART, the frequency threshold is typically set in range of 25 Hz: transmissions below this threshold—analog signals—are allowed to pass through; transmissions above this threshold—HART digital signals—are filtered.

M

MAC address

Media Access Control address: A 48-bit number, unique on a network, that is programmed into each network card or device when it is manufactured.

Modbus

An application layer messaging protocol. Modbus provides serial communications between master and slave devices connected on different types of buses or networks.

multiplexer

A multiplexer (MUX) is a device that selects one of several input signals and forwards the selected input into a single line.

N

NaN

Not a number: A numeric data type value representing an undefined or unrepresentable value.

NEMA

National Electrical Manufacturers Association

P

PE

protective ground: An equipment grounding conductor that keeps the exposed conductive surfaces of equipment at earth potential. A PE conductor does not enhance or facilitate the operation of the equipment. Its purpose is to guard the operator against potential electric shock. Contrast: *functional ground (FE)*.

PLC

programmable logic controller: The PLC is a digital computer used for automation of electromechanical processes, such as control of machinery. PLCs are used in many industries and machines. The PLC is designed to:

- communicate via multiple inputs and outputs
- operate in an extended range of temperatures
- perform under conditions that may include dust, water, electrical noise, vibration and impact

Programs to control machine operation are typically stored in non-volatile memory. A PLC is designed to provide highly deterministic performance, within predictable time boundaries.

primary master
In HART, when two master devices are connected to the HART communication network, the HART controller. The HART primary master is typically asset management software resident on a PC.

R

RFI
radio frequency interference: See *EMI*.

S

scanner
The originator of I/O connection requests for implicit messaging in EtherNet/IP, and message requests for Modbus TCP.

secondary master
In HART, when two master devices are connected to the HART communication network, a hand-held master device temporarily connected to the network.

SELV
safety extra low voltage: A secondary circuit designed so that the voltage between any 2 accessible parts (or between 1 accessible part and the PE terminal for Class 1 equipment) does not exceed a specified value under normal conditions or under single point of failure conditions. Schneider Electric's Phaseo ABL8 range of power supplies has products that comply with the SELV standard in IEC/EN 60364-4-41.

sink load
An output that, when turned on, receives DC current from its load.

source load
A load with a current directed into its input; it is driven by a current source.

T

TCP
transmission control protocol:. A connection-oriented transport layer protocol that provides full-duplex data transmission. TCP is part of the TCP/IP suite of protocols.

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